Vol. 40 No. 5

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MAY, 1913

A taxonomic study of the Pteridophyta of the Hawaiian Islands—III

WINIFRED J. ROBINSON

(WITH PLATES 9–12)

19. POLYPODIUM L. Sp. Pl. 1082. 1753

A cosmopolitan genus, including ferns of every habitat. Rootstock creeping; leaves articulate; blades various, mostly simple or pinnate; veins free or occasionally anastomosing; sori orbicular, dorsal on the veins, non-indusiate.

Type species: *Polypodium vulgare* L.

Leaves simple to deeply pinnatifid, not bearing reddish, resinous glands beneath.
- Leaves simple.
  - Margin entire or very slightly undulate.
    - Rootstock creeping, 5–8 mm. in diameter, the scales light brown; leaves 8–20 cm. × 7.5–10 mm.
      - Leaves stalked, pubescent with numerous reddish brown hairs 2–3 mm. long; margin entire; sori inframedial. *P. Hookeri.*
      - Leaves sessile, pubescent with scattered whitish hairs less than 1 mm. long; margin slightly undulate; sori supramedial. *P. Knudsenii.*
    - Rootstock erect or creeping, less than 5 mm. in diameter, the scales dark brown; leaves 5–7 cm. × 2–5 mm.
      - Rootstock erect, rather stout; leaves subsessile, linear-lanceolate, entire; sori oval, numerous. *P. pumilum.*
      - Rootstock creeping, wiry; leaves stalked, linear, slightly undulate; sori round, few, distant. *P. pseudogrammitis.*

[The BULLETIN for April 1913 (40: 137-192. *pl. 3–8*) was issued May 9.]

Margin crenate to serrate, at least in the lower part; rootstock erect; leaves 10–15 cm. × 2–4 mm.
Margin crenate or dentate from base to apex; sori oval, alternate, supramedial on serrations. *P. Haaliliolanum.*
Margin sinuately pinnatifid below, subentire in apical third; sori oval, inframedial. *P. Saffordii.*

Leaves pinnatifid.
Basal segments reduced to a wing along the midrib; lower surface and margin marked by scattered, brownish glandular hairs.
Leaves elliptic-lanceolate to elliptic-caudate, 8–15 cm. × 1–2.5 cm.; sori nearly covering leaf tissue from costa to margin. *P. sarmentosum.*
Leaves linear to narrowly oblanceolate, 15–25 cm. × 1.5–2 cm.; sori inframedial. *P. Adenophorus.*
Basal segments scarcely reduced; leaves ovate-oblong, segments varying from linear to lanceolate with narrow sinuses between them, to oblong and obtuse with broad sinuses; pellucid lines between the veins. *P. pellucidum.*

Leaves bipinnatifid to deeply tripinnatifid, bearing numerous, reddish, resinous glands beneath.
Leaves bipinnatifid.
Leaves linear, 5–15 cm. × 5–7.5 mm., pinnae divided into 2 or 3 segments. *P. hymenophylloides.*
Leaves not linear; pinnae divided into 6 to 15 segments.
Leafstalk 0.5 mm. in diameter; blades oblong-ovate, 3.5–5 cm. × 1–2 cm.; pinnae compact. *P. abietinum.*
Leafstalk 1–2 mm. in diameter; blades more than 10 cm. long.
Leaves subcoriaceous, blades ovate-lanceolate; pinnae oblong, 20–30 cm. × 6–8 cm.; segments linear; sori narrower than the segments. *P. Hillebrandii.*
Leaves chartaceous, blades elliptic-lanceolate to elliptic-caudate, 10–35 cm. × 2–5 cm., pinnae lanceolate; segments oblanceolate to spatulate; sori as broad as the segments. *P. tamariscinum.*

Leaves tripinnatifid; pinnae 15–25 cm. × 2–3 cm.; segments spatulate; sori as broad as the segments. *P. Gaudichaudii.*

POLYPODIUM HOOKERI Brack. Fil. U. S. Expl. Exp. 4. 1854

Polypodium setigerum Hook. & Arn. Bot. Beech. 103. 1832. Not Blume.

Grammitis setigera J. Sm. Hist. Fil. 181. 1875.

TYPE LOCALITY: Oahu.

DISTRIBUTION: Polynesia, Hawaiian Islands.

ILLUSTRATION: Hook. & Arn. Bot. Beech. *pl. 21. f. a.* 1832.

SPECIMENS EXAMINED: Hawaii, *Mann & Brigham 482* N; *Robinson 201* V; Maui, *Robinson 336* V; *338* V; *352* V; Oahu, *Heller 2245* C, N; *Lichtenthaler* N; Hawaiian Islands, *Baldwin 81* C, N; *Baldwin* B; *Hillebrand* B; ex Herb. Underwood C; *Hillebrand* N.

This is closely allied to *P. setosum* (Blume) Presl, according to Copeland, Polypodiaceae of the Philippine Islands, Bur. Gov. Lab. Publ. **21**: 119. 1905.

POLYPODIUM KNUDSENII Hieron. Hedwigia **44**[2]: 79. 1905

Polypodium samoense var. *glabra* Hilleb. Fl. Haw. Is. 554. 1888. Not *P. glabrum* Roxb.

Polypodium samoense Christ in Engler, Bot. Jahrb. **23**: 358. 1896, in part. Not Baker.

TYPE LOCALITY: Kauai, Hawaiian Islands.

DISTRIBUTION: On trees, Kauai, Hawaiian Islands.

SPECIMENS EXAMINED: Kauai, *Baldwin 17* B; *Heller 2708* B; C, K, N; *Knudsen 7* B; *Robinson 405* V; *440* V; *453* V; *826* V; *836* V.

Hieronymus (Hedwigia **44**[2]: 79. 1905) distinguishes *P. Knudsenii* from *P. samoense* by the broader, yellow rather than ferruginous, scales of the rhizome; the fewer, smaller hairs upon the leafstalk; the thicker texture and more pointed apex of the leaf; the less evident veins; the larger size of the sori and their greater proximity to the margin of the leaf.

Polypodium pumilum sp. nov.

Rootstock short, erect, less than 1 mm. in diameter, covered with dark brown, linear-lanceolate scales 1–2 mm. long and 0.3–0.5 mm. broad at the base, with 6–10 rows of cells in the broadest part; roots numerous; leaves 3–5, simple, nearly sessile, cespitose, linear-oblanceolate, obtuse or bluntly acute at apex, narrowed gradually at the base, 4–7 cm. long, 3–5 mm. wide, the margin subentire, the midrib green, prominent; veins forked once about 2 mm. from the midrib; sori oblong, 1.5–2 mm. long by 1–1.5 mm. broad; sporangia flattened laterally, the annulus of 10–12 cells; spores yellow, tetrahedral, 0.040 mm. in diameter, very minutely tuberculate. [FIG. 1.]

Type collected on Oahu, 1000 m. elevation, 1890, by D. D. Baldwin, distributed by D. C. Eaton as *P. sessilifolium* (herb. N. Y. Bot. Gard.).

Known only from the type locality.

The present species differs from *P. Knudsenii* Hieron. in its smaller size; in the size of the scales, which in the latter are 3–4

FIG. 1. *Polypodium pumilum*, natural size.

mm. long and 0.5–0.8 mm. wide, with 10–20 rows of cells in the broadest part; and in the smooth margin of the leaf in contrast with the hairy margin of *P. Knudsenii*.

POLYPODIUM PSEUDOGRAMMITIS Gaud. Voy. Freyc. Bot. 345. 1828

Grammitis tenella Kaulf. Enum. 84. 1824. Not Forster.
Polypodium Kaulfussii Presl, Tent. Pterid. 178. 1836.

TYPE LOCALITY: Oahu.

DISTRIBUTION: On trees, common; Hawaiian Islands.

ILLUSTRATIONS: Hook. & Arn. Bot. Beech. *pl. 21.* 1832; Kunze, Anal. Pterid. *pl. 9. f. 1.* 1837.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B, C; *Robinson 236* V; *260* V; *275* V; Oahu, *Heller 2215* C; *Macrae* B; *Robinson 2* V; *9* V; *45* V; *119* V; Kauai, *Robinson 446* V; Hawaiian Islands, *Baldwin 32* B; *83* B, C; *Gaudichaud* B; *Wilkes Expedition* B, C.

POLYPODIUM HAALILIOLANUM Brack. Fil. U. S. Expl. Exp. 5. 1854

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: On tree trunks above 600 m. elevation, Hawaiian Islands; rare.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 1. f. 4.* 1854.

SPECIMENS EXAMINED: Hawaii, *Robinson 601* V; Oahu, *Hillebrand* B; *Mann & Brigham 178* N; *Wilkes Expedition* N; Kauai, *Lichtenthaler* N; Hawaiian Islands, *Baldwin 86* B; C; *Hillebrand* C.

Hieronymus (Hedwigia **44**[2]: 86. 1905) reduces *Polypodium Haaliliolanum* to *Polypodium subpinnatifidum* Blume, but the type of the latter at Berlin has subpinnatifid lobes and acute sinuses, while the leaves of the Hawaiian plant are sinuato-crenate throughout. The sporangia of *Polypodium Haaliliolanum* are smooth, while those of *Polypodium subpinnatifidum* are setose.

POLYPODIUM SAFFORDII Maxon, Am. Fern Jour. **2**: 19. 1912

Polypodium minimum Brack. Fil. U. S. Expl. Exp. 5. *pl. 1. f. 3.* 1854. Not Aublet.

Polypodium serrulatum var. *lata* Luerssen, in Wawra, Flora **58**: 422. 1875.

Polypodium serrulatum Hilleb. Fl. Haw. Is. 553. 1888. Not Mett.

TYPE LOCALITY: Oahu.

DISTRIBUTION: Common on trees above 600 m. elevation, Hawaiian Islands.

ILLUSTRATIONS: Brack. Fil. U. S. Expl. Exp. *pl. 1. f. 3.* 1854; Maxon, Am. Fern Jour. **2**: 19. 1912.

SPECIMENS EXAMINED: Hawaii, *Lichtenthaler* N; *Robinson 600* V; Oahu, *Heller 2905* (type) N, (cotype) C; *Mann & Brigham 550* N; *Robinson 521* V; *Wilkes Expedition* N; Kauai, *Hillebrand 123* B; Hawaiian Islands, *Baldwin 85* B, C; *Bishop 81* B; *Johnson* B; ex Herb. Mt. Holyoke College B; *Wilkes Expedition* C.

POLYPODIUM SARMENTOSUM Brack. Fil. U. S. Expl. Exp. 8. 1854

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Common on rocks and decayed wood, Hawaiian Islands.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 2. f. 3.* 1854.

SPECIMENS EXAMINED: Hawaii, *Robinson 203* V; Maui, *Bailey* C; *Robinson 356* V; Oahu, *Forbes* BM; *Heller 2353* C, N; *Lichtenthaler* N; *Mann & Brigham 200* N; *Robinson 1* V; *5* V; *46* V; *67* V; *117* V; *Safford 889* N; Kauai, *Robinson 856* V; *418* V; Hawaiian Islands, *Baldwin 82* C, N; *Wilkes Expedition* C; ex Herb. John Donnell Smith N.

POLYPODIUM ADENOPHORUS Hook. & Arn. Bot. Beech. 104. 1832

Adenophorus pinnatifidus Gaud. Voy. Freyc. Bot. 365. 1829. Not Gilib.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: On tree trunks in the forests above 600 m. elevation.

ILLUSTRATION: Hook. & Arn. Bot. Beech. *pl. 22.* 1832.

SPECIMENS EXAMINED: Oahu, *Lichtenthaler* N; *Mann & Brigham 283* N; Kauai, *Knudsen* B; *Robinson 851* V; Hawaiian Islands, *Baldwin 88* B, C; *Wilkes Expedition* C, N; ex Herb. John Donnell Smith N.

POLYPODIUM PELLUCIDUM Kaulf. Enum. 101. 1824

Polypodium myriocarpum Hook. Ic. Pl. *pl. 84.* 1837.

Polypodium hawaiiense Underw. in Heller, Minn. Bot. Stud. 1: 784. 1897.

Polypodium Helleri Underw. in Heller, Minn. Bot. Stud. 1: 785. 1897.

Polypodium vulgare Christ, Farnkr. Erde 83. 1909.

TYPE LOCALITY: Oahu.

DISTRIBUTION: On ground and on tree trunks, at 300–2,000 m. elevation; Hawaiian Islands.

ILLUSTRATIONS: Hook. Ic. Pl. *pl. 84.* 1837; *pl. 944, 945.* 1854.

SPECIMENS EXAMINED: Hawaii, *Dale* C; *Robinson 144* V; *254* V; *267* V; *Wilkes Expedition* C; Maui, *Bishop 83* B; *84* B; *Finsch 11* B; *60* B; *Robinson 316* V; *324* V; *333* V; Molokai, *Hillebrand* B; Oahu, *Chamisso* B; *Forbes 1017* BM; *Heller 2075* C; *Robinson 7* V; Kauai, *Forbes 268* BM; *Heller 2602* C; *2634* C; *Hillebrand 54* B; *Knudsen 55* B; *56* B; *Robinson 403* V; *482* V; Hawaiian Islands,

Baldwin 89a B; *89c* B; *89* C; *Bailey* C; *Douglas 69* B, C; *Gaudichaud* B; *Lydgate* B; *Wilkes Expedition* B, C.

Polypodium pellucidum is extremely polymorphous, as is shown by the several nominal species that have been segregated at different times. Kaulfuss's type in the Berlin herbarium is very coriaceous and has the intermediate veinlike striations mentioned by this author. The pinnae are rather acute, 4–5 cm. long, with crenate-undulate margins. Divergences from this are seen in: (1) *P. Helleri* Underw. (type *Heller 2602*) with longer thinner pinnae; a single incomplete leaf has greatly elongated pinnae; (2) *P. hawaiiense* Underw. with broader (1.5 cm.), shorter (3–4.5 cm.), rounded pinnae, Hillebrand's var. *opacum* from Molokai; (3) *P. myriocarpum* (Hook. Ic. Pl. 1: *pl. 84*) apparently a monstrous form with great variability in the pinnae of the same leaf; (4) a form still more common in collections, which has close or spaced pinnae ranging from rounded to pointed on the same leaf. Near the extinct craters, about a mile from the Volcano House, Hawaii, the leaves are folded ventrally upon the midrib. A field study of the range of variations of the species would form an interesting local problem.

POLYPODIUM HYMENOPHYLLOIDES Kaulf. Enum. Fil. 118. 1824

Amphoradenium minutum Desv. Prod. 336. 1827.

Adenophorus hymenophylloides Hook. & Grev. Ic. Fil. *pl. 176.* 1829.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Rare, on trees at elevations of 1,000–1,600 m., Hawaiian Islands.

ILLUSTRATIONS: Gaud. Voy. Freyc. Bot. *pl. 8.* Hook. & Grev. Ic. Fil. *pl. 176.* 1829.

SPECIMENS EXAMINED: Hawaii, *Robinson 276* V; forest above Cape Lua Pele, *Wilkes Expedition* N; *Wilkes Expedition 19* B, C; Maui, *Robinson 347* V; *Wilkes Expedition* B, C, N; Oahu, *Beechey* C; *Diell* C; *Robinson 87* V; *97* V; Kauai, *Heller 2213* C, N; *Knudsen 154* B; *Robinson 462* V; Hawaiian Islands, *Baldwin 90* B, C, N; *Gaudichaud* B, C; *Hillebrand* B; *Mann & Brigham 276* N.

POLYPODIUM ABIETINUM D. C. Eaton, in Mann, Proc. Am. Acad. **7**: 219. 1867

Polypodium tamariscinum var. *abietinum* Hilleb. Fl. Haw. Is. 557. 1888.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: On trees, rare; Hawaiian Islands.

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition* N; Oahu, *Hillebrand* B; *Remy* C; *Robinson 32* V; *48* V; *Wilkes Expedition* N; Kauai, *Heller 2732* C; N; *Hillebrand* B; *Lichtenthaler* N; Hawaiian Islands, *Baldwin 94* B; C; *Hillebrand* B.

POLYPODIUM HILLEBRANDII Hook. Sp. Fil. **4**: 228. 1862

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: At 400–700 m. elevation, rare; Hawaiian Islands.

ILLUSTRATION: Hook. Sp. Fil. **4**: *pl. 279A*. 1862.

SPECIMENS EXAMINED: Hawaii, *Robinson 287* V; Oahu, *Forbes* BM; *Robinson 23* V; *123* V; Hawaiian Islands, *Baldwin 92* C, N; *Baldwin 93* C; *Hillebrand* B, C; *Safford 891* N; ex Herb. John Donnell Smith N; *Wilkes Expedition* C.

POLYPODIUM TAMARISCINUM Kaulf. Enum. Fil. 117. 1824

Adenophorus bipinnatus Gaud. Ann. Sci. Nat. **3**: 508. 1824.

TYPE LOCALITY: Oahu.

DISTRIBUTION: Hawaiian Islands.

ILLUSTRATION: Hook. & Grev. *pl. 175*. 1829.

SPECIMENS EXAMINED: Hawaii, *Robinson 208* V; *248* V; Oahu, *Copeland* N; *Heller 2214* N; *Lichtenthaler* N; *Mann & Brigham 198* N; *Robinson 83* V; *91* V; *92* V; *118* V; *122* V; *Safford 892* N; Kauai, *Robinson 463* V; *495* V; *832* V; Hawaiian Islands, *Baldwin 91* N; ex Herb. John Donnell Smith N.

POLYPODIUM TRIPINNATIFIDUM (Gaud.) Presl, Tent. Pterid. 178. 1836

Adenophorus tripinnatifida Gaud. Ann. Sci. Nat. **3**: 508. 1824; Voy. Freyc. Bot. *pl. 8*. 1826.

Amphoradenium Gaudichaudii Desv. Prod. 336. 1827.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Above 600 m. elevation, Hawaiian Islands.

ILLUSTRATION: Gaud. Voy. Freyc. Bot. *pl. 8.*

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition* N; Maui, *Lichtenthaler* N; Molokai, *Baldwin 93a* B; *93b* B; Kauai, *Remy 16* C; Hawaiian Islands, *Hillebrand 122* B; *Wilkes Expedition 20* B, C.

20. PHYMATODES Presl, Tent. Pterid. 195. 1836

Tropical plants, mostly epiphytic; rootstock creeping; leaves articulate, distant, simple; veins obscure or prominent, anastomosing, with free included veinlets; sorus borne upon anastomosing veins or upon the clavate apex of an included vein, non-indusiate.

Type species: *Polypodium zosteraeforme* Wall.

Leaves linear-lanceolate; veins obscure; sori round, nearly covering leaf from costa to margin, light brown. *P. elongata.*
Leaves palmately lobed; veins prominent; sori small, dark. *P. Spectrum.*

PHYMATODES ELONGATA Presl, Tent. Pterid. 196. 1836

Polypodium lineare Thunb. Fl. Jap. 335. 1784. Not Burm.
Pleopeltis nuda Hook. Fil. Exot. 63. 1823.
Pleopeltis linearis Kaulf. Enum. 246. 1824.
Pleopeltis Thunbergiana Kaulf. Wes. d. Farrenkr. 113. 1827.
Polypodium leiopteris Kunze, Klotzsch, Linnaea **23**: 319. 1850.
Drynaria nuda Fée, Gen. **1**: 270. 1850–52.
Drynaria elongata Brack. Fil. U. S. Expl. Exp. 42. 1854.
Niphobolus linearis Keyserl. Polyp. Cyath. Herb. Bung. 39. 1873.

TYPE LOCALITY: Kosido, Japan.

DISTRIBUTION: On trees and rocks; tropical countries.

SPECIMENS EXAMINED: Hawaii, *Lichtenthaler* N; Maui, *Wilkes Expedition* N; *O. Finsch 10* C; Kauai, *Heller 2533* C; *3533* N; Oahu, *Wilkes Expedition* C; *Diell* C; *Heller 2005* C, N; *2076* C, N; *2031* C, N; *Mann & Brigham 177* N; *Robinson 84* V; *Safford 893* N; *1887* N; Hawaiian Islands, *Baldwin 82* C, N; *R. H. Hitchcock* C; ex Herb. John Donnell Smith N.

PHYMATODES SPECTRUM (Kaulf.) Presl, Tent. Pterid. 197. 1836

Polypodium Spectrum Kaulf. Enum. 94. 1824.
Polypodium Thouinianum Gaud. Voy. Freyc. Bot. 348. 1828.

Drynaria spectrum J. Sm. Jour. Bot. Hook. **4**: 61. 1842.
Pleopeltis spectrum Moore, Ind. Fil. 348. 1862.
Colysis Spectra J. Sm. Ferns Brit. & For. 98. 1866.

TYPE LOCALITY: Oahu.

DISTRIBUTION: On rocks and tree trunks in dense shade of woods, Hawaiian Islands, Sumatra.

ILLUSTRATIONS: Gaud. Voy. Freyc. Bot. *pl. 5. f. 1.* E. & P. Nat. Pfl. 1^4: 317. *f. 164A, B.* 1899.

SPECIMENS EXAMINED: Hawaii, *Robinson 200* V; Maui, *Wilkes Expedition* C; Oahu, *Heller 2118* C; *Robinson* V; Kauai, *Heller 2438* C; Hawaiian Islands, *Baldwin 84* C; *Miss Sessions* C; ex Herb. Kew. C.

The leaves of *Phymatodes Spectrum* vary so much in size and cutting of the lobes as to suggest different species for those found growing upon a single rootstock.

21. PHLEBODIUM (R. Br.) J. Sm. Jour. Bot. **4**: 58. 1842

Tropical or subtropical plants, usually epiphytic. Rootstock creeping, 1–2 cm. in diameter, paleaceous; leaves articulate; blades pinnatifid or pinnate; primary veins pinnately arranged, the secondary veins anastomosing; sori usually terminal on two included veinlets, non-indusiate.

Type species: *Polypodium aureum* L.

PHLEBODIUM AUREUM (L.) J. Sm. Jour. Bot. Hook. **4**: 58. 1842

TYPE LOCALITY: West Indies.

DISTRIBUTION: On ground and on trees, West Indies, Florida, Mexico, Brazil, Hawaiian Islands.

ILLUSTRATIONS: Plumier, Traité Foug. *pl. 76.* 1705. PLATE 9.

SPECIMENS EXAMINED: Wahiawa Mts., Kauai, *Forbes 308* BM.

Forbes 308 is the first collection of this species that has been noted for the Hawaiian Islands, and it may be that it is an escape from cultivation, though the remoteness of the locality where it was collected makes its origin from a cultivated plant improbable.

Mr. Forbes notes: "All the fronds were remarkably glaucous blue."

22. POLYSTICHUM Roth, Röm. Mag. 2^1: 106. 1799

Mostly coarse and rigid terrestrial plants of cosmopolitan distribution; rootstock short, erect; leaves cespitose, not articu-

late; blades pinnate to quadripinnate; veins free; sori roundish, dorsal upon the veins; indusium centrally peltate, orbicular.

Type species: *Polypodium Lonchitis* L.

Leaves tripinnate, ovate-lanceolate, smooth or slightly tomentose. *P. carvifolium.*
Leaves bipinnate; stipe and rachis densely covered with linear-lanceolate scales.
  Pinnae 1.5–3 cm. apart, sharply aristate. *P. haleakalense.*
  Pinnae crowded, margins entire or nearly so. *P. Hillebrandii.*

POLYSTICHUM CARVIFOLIUM (Kunze) C. Chr. Ind. Fil. 70. 1905

Polystichum coniifolium J. Sm. Jour. Bot. Hook. **3**: 413. 1841. Not Presl.

Aspidium curvifolium Kunze, Bot. Zeit. **6**: 283. 1848.

Aspidium aristatum Sw. var. *coniifolium* Wall.; Hook. Sp. Fil. **4**: 27. 1862.

Dryopteris coniifolia Underw. in Heller, Minn. Bot. Stud. **1**: 778. 1897.

TYPE LOCALITY: Philippine Islands.

DISTRIBUTION: High plateaus, China, Japan, Polynesia, Hawaiian Islands, Australia.

SPECIMENS EXAMINED: *Heller 2817* C; *Baldwin 62* C.

The habit, coriaceous texture, and aristate pinnae of this plant place it in *Polystichum* rather than in *Dryopteris*. The indusia are sometimes reniform-orbicular, sometimes peltate, on the same leaf. It is very different from the Japanese *Polystichum aristatum* (Forster) Presl, in rootstock, texture, and the division of the leaf.

POLYSTICHUM HALEAKALENSE Brack. Fil. U. S. Expl. Exp. 204. 1854

Aspidium haleakalense Mann, Proc. Am. Acad. **7**: 216. 1867.

Aspidium aculeatum var. *Braunii* Hilleb. Fl. Haw. Is. 568. 1888. Not Swartz.

TYPE LOCALITY: Region of Sophora, Mauna Kea, Hawaii.

DISTRIBUTION: In forests at altitudes of 1,800–2,700 m., Hawaiian Islands.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 28*. 1854.

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition* N; Maui, *Lichtenthaler* N; *Finsch 45* B; *Lydgate* B; *Lydgate & Baldwin* B; *Mann & Brigham 481* N; *Mann* B; ex Herb. Mt. Holyoke College C; Oahu, *Macrae* B; Hawaiian Islands, *Baldwin 61* C, N; ex Herb. John Donnell Smith N.

POLYSTICHUM HILLEBRANDII Carruth. in Seem. Fl. Vit. 358. 1873

Aspidium Hillebrandi Hilleb. Fl. Haw. Is. 568. 1888.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: In forests at altitudes of 1,500–1,800 m., Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Bailey* C; *Baldwin* B, C, V; *Lydgate* B; Hawaiian Islands, *Baldwin 60* B, C.

23. CYRTOMIUM Presl, Tent. Pterid. 86. 1836

Rootstock short; leaves clustered, pinnate, somewhat coriaceous; veins anastomosing; sori globose, dorsal upon free included veinlets or upon connecting veins; indusium peltate.

Type species: *Cyrtomium caryotideum* (Wall.) Presl.

Leaves less than 15 cm. long, with a single row of areolae on either side of the midvein. *C. Boydiae.*

Leaves more than 15 cm. long, with several areolae between midrib and margin. *C. caryotideum.*

Cyrtomium Boydiae (D. C. Eaton) comb. nov.

Aspidium Boydiae D. C. Eaton, Bull. Torrey Club **6**: 361. 1879.

Aspidium cyatheoides var. *depauperatum* Hilleb. Fl. Haw. Is. 572. 1888.

Dryopteris cyatheoides C. Chr. Ind. Fil. 66. 1906.

TYPE LOCALITY: Oahu.

DISTRIBUTION: On rocky ledges, along streams, Hawaiian Islands.

ILLUSTRATION: PLATE 10.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; Maui, *Baldwin* C, V; Oahu, *Forbes* BM; *Rock* V.

CYRTOMIUM CARYOTIDEUM (Wall.) Presl, Tent. Pterid. 86. 1836

Aspidium caryotideum Wall. Cat. no. 376. 1828.

Dryopteris caryotidea Underw. in Heller, Minn. Bot. Stud. **1**: 779. 1897.

TYPE LOCALITY: Nepal.

DISTRIBUTION: In forests, India, Polynesia, Hawaiian Islands.

ILLUSTRATIONS: Hook. & Grev. Ic. Fil. *pl. 69.* 1826; Presl, Tent. Pterid. *pl. 2. f. 12.* 1836; Brack. Fil. U. S. Expl. Exp. *pl. 16.* 1854; Hook. Garden Ferns *pl. 13.* 1862.

SPECIMENS EXAMINED: Hawaii, *Lichtenthaler* N; Maui, *Mann & Brigham 487* N; *Wilkes Expedition* N; Kauai, *Heller 2544* C, N; *Hillebrand* B; *Lydgate* B; Lanai, *Hillebrand* B; Oahu, *Forbes 431* BM; Hawaiian Islands, *Baldwin 59* B, C; *Remy* B; *Miss Sessions* C.

Christensen, following Diels (E. & P. Nat. Pfl. 1^4: 194. 1899), makes *Cyrtomium caryotideum* a synonym of *Polystichum falcatum* (L. f.) Diels. However, as *Polystichum* has free veins and this group has anastomosing veins, they are separated on that character rather than combined on the similarity of their indusia. The type of *Polystichum falcatum* is from Japan. Thunberg, Fl. Jap. 336. *pl. 36.* 1784, describes and figures it, but his figure represents a plant with cordate-falcate leaves not auricled, with scales at the base of the leafstalk. The Hawaiian plant resembles Wallich's specimen at Kew, a tracing from which is in the herbarium of the New York Botanical Garden.

24. TECTARIA Cav. Anal. Hist. Nat. **1**: 115. 1799

Rootstock creeping or decumbent; leaves clustered, not articulate, various in form, chartaceous; veins reticulate with free included veinlets; leafstalk purplish brown, smooth above, scaly at the base; sori circular; indusium orbicular, attached at the center.

Type species: *Polypodium trifoliatum* L.

Tectaria cicutaria (L.) comb. nov.

Polypodium cicutarium L. Syst. Nat. ed. 10. **2**: 1326. 1759.
Aspidium cicutarium Sw. Jour. Bot. Schrad. **1800**^{2}: 36. 1801.
Aspidium apifolium Schkuhr, Krypt. Gew. **1**: 198. 1809.
Nephrodium apifolium Hook. & Arn. Bot. Beech. 105. 1832.
Sagenia apiifolia (Schkuhr) J. Sm. Jour. Bot. Hook. **4**: 184. 1841.

TYPE LOCALITY: Jamaica, B. W. I. (?).

DISTRIBUTION: In the tropics, on damp rocks, or in depths of shady forests.

ILLUSTRATIONS: Pluk. Almag. 156. *pl. 296. f. 2.* 1692; Schkuhr, Krypt. Gew. *pl. 56b.* 1809; Hook. & Grev. Ic. Fil. *pl. 202.* 1831.

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition* N; Maui, *Bailey* C; *Baldwin* N; *Robinson 314* V; *328* V; *339* V; Oahu, *Beechey* (ex Herb. Mettenius) C; *Mann & Brigham 189* N; *Robin-*

son 13 V; *18* V; *135* V; *Safford 914* N; *915* N; *916* N; *Wilkes Expedition* N; Kauai, *Heller 2842* C, N; *Hillebrand 60* B; *Knudsen 68* B; Hawaiian Islands, *Baldwin 68* B, C, N; *Hillebrand* (ex herb. Berlin) C; *Lindley* C; *Miss Sessions* C; ex Herb. Underw. C; ex Herb. John Donnell Smith N; *Wilkes Expedition* C, N.

25. NEOTTOPTERIS J. Sm. Jour. Bot. Hook. 3: 409. 1841

A genus of epiphytic ferns, with fleshy, orchid-like roots, found in the forests of tropical Asia, Polynesia, Australia, and Africa. Rootstock erect, short; leaves large, simple, cespitose, sessile or nearly so, spreading, glabrous, entire, arranged spirally with short internodes; veins slender, parallel, close (less than 1 mm. apart), oblique to the midrib, connected by a transverse intramarginal vein at their apices; sori linear, extending from near the midrib ½ to ⅔ the length of the veins in the distal half or two thirds of the leaf.

Type species: *Neottopteris Nidus* (L.) J. Sm.

NEOTTOPTERIS NIDUS (L.) J. Sm.; Hook. & Bauer, Gen. Ferns *pl. 113B.* 1842

Asplenium Nidus L. Sp. Pl. 1079. 1753.
Thamnopteris Nidus Presl, Epim. 68. 1849.

TYPE LOCALITY: Java.

DISTRIBUTION: On trees and on humus soil in forests, usually below 700 m., tropical Asia, Australia, Madagascar, and Polynesia.

ILLUSTRATIONS: Hook. & Bauer, Gen. Ferns *pl. 113B.* 1842; Breyne, Exot. Pl. Cent. *pl. 99.* 1678.

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition* N; Maui, *Bailey* C; Oahu, *Didrichsen 3652* C; *Gaudichaud* B; *Hillebrand* B; *Meyen* B; *Robinson 17* V; *103* V; Kauai, *Heller 205* C; Hawaiian Islands, *Baldwin 30* C; *Mann & Brigham 137* N; *Safford 31* N; *Miss Sessions* C.

26. ASPLENIUM L. Sp. Pl. 1078. 1753

A genus of world-wide distribution, especially well represented in the temperate zones, though including many tropical forms.

Rootstock erect or creeping; leaves non-articulate, usually cespitose; blades simple to quadripinnate, coriaceous to mem-

branaceous; veins free in Hawaiian species; sori linear upon the veins, usually oblique to the midrib or leading vein of the pinna, occasionally parallel with it; indusia attached to veins, opening towards the midrib; sori occasionally athyrioid or diplazioid.

Leafblades simply pinnate.
- Pinnae orbicular to rhomboidal or oblong, subentire.
  - Rootstock creeping; leaves distant. — *A. unilaterale.*
  - Rootstock short, erect; leaves cespitose.
    - Leafstalk dull green, flexuose.
      - Pinnae rhomboidal to flabellate, occasionally distant, gradually reduced below. — *A. rhomboideum.*
      - Pinnae ovate-obtuse, approximate, abruptly reduced below. — *A. lunulatum.*
    - Leafstalk dark brown or black, rigid.
      - Blade chartaceous; sori on veins parallel to the lower margin, opening upwards. — *A. monanthes.*
      - Blade subcoriaceous; sori on secondary veins, indusium opening toward primary vein.
        - Blade 2.5–10 cm. long; pinnae ovate to suborbicular. — *A. Trichomanes.*
        - Blade 15 cm. long; pinnae oblong. — *A. pavonicum.*
- Pinnae lanceolate, margin serrate, incised, or lobed.
  - Leafstalks green.
    - Pinnae auricled at base. — *A. pseudofalcatum.*
    - Pinnae not auricled at base.
      - Leafblade coriaceous; basal scales of leafstalk ovate.
        - Pinnae obtuse at apex; broadly ovate; sorus conterminous with vein; veins obscure. — *A. Kaulfussii.*
        - Pinnae caudate; sorus shorter than vein; veins distinct. — *A. kauaiense.*
      - Leafblade chartaceous; basal scales lanceolate or linear.
        - Leafblade 30–35 cm. long, oblong-ovate; basal scales of leafstalk lanceolate. — *A. enatum.*
        - Leafblade 20–25 cm. long, oblong-lanceolate; basal scales of leafstalk linear. — *A. Hillebrandii.*
  - Leafstalks brown or steel-blue.
    - Pinnae serrate or incised.
      - Pinnae caudate.
        - Primary veins parallel to the midrib. — *A. contiguum.*
        - Primary veins divergent from the midrib. — *A. caudatum.*

Pinnae acuminate. *A. nitidulum.*
Pinnae cut into rhombic lobes.
Leafstalk and midrib paleaceous. *A. horridum.*
Leafstalk and midrib smooth. *A. glabratum.*
Leafblades more than once pinnate.
Blades bipinnatifid to bipinnate, upper basal pinnule auriculate. *A. lobulatum.*
Blades bipinnate to quadripinnate, basal pinnules various.
Blades bipinnate to tripinnatifid.
Blades chartaceous.
Blades under 35 cm. long.
Blades oblong, ultimate divisions flabellate.
Blades 3.75–7 cm. ×12–18 mm. *A. varians.*
Blades 20–30 cm. ×18–45 mm. *A. Macraei.*
Blades lanceolate, ultimate divisions ovate-lanceolate. *A. Lydgatei.*
Blades over 35 cm. long.
Pinnae linear-lanceolate, patent; pinnules obliquely trapezoid-ovate. *A. Goldmannii.*
Pinnae lanceolate, approximate; pinnules rhomboidal, basal pinnules occasionally auriculate. *A. acuminatum.*
Blades coriaceous.
Blades oblong, ultimate divisions obovate or truncate.
Pinnae obliquely rhomboidal, approximate. *A. rhipidoneuron.*
Pinnae ovate oblong, patent.
Blades lanceolate. *A. insiticium.*
Ultimate divisions flabellate or truncate, pinnae approximate. *A. cuneatum.*
Ultimate divisions ovate-lanceolate, patent. *A. parallelum.*
Blades tripinnate to quadripinnate.
Blades broadly oblong. *A. patens.*
Blades deltoid or deltoid lanceolate.
Blades broadly deltoid, 10–20 cm. long. *A. Adiantum-nigrum.*
Blades deltoid lanceolate, 30 cm. or more long.
Blades membranaceous; ultimate divisions spinulose. *A. vexans.*
Blades thick, chartaceous.
Rachis winged; ultimate divisions spatulate, less than 2 mm. broad. *A. schizophyllum.*
Rachis not winged; ultimate divisions 4 mm. or more broad. *A. sphenotomum.*

ASPLENIUM UNILATERALE Lam. Encyc. **2**: 305. 1786

Asplenium resectum J. E. Sm. Pl. Ic. Ined. 3. *pl. 72.* 1790–91.
Asplenium amoenum Presl, Tent. Pterid. 107. 1836.
Asplenium emargino-dentatum Zenker; Kunze, Linnaea **24**: 263. 1851.

TYPE LOCALITY: Mauritius.

DISTRIBUTION: In wet, shady localities, Mauritius, Japan, China, Polynesia, Hawaiian Islands.

SPECIMENS EXAMINED: Hawaii, *Robinson 622* V; *Wilkes Expedition* N; Maui, *Bailey* C; *Lichtenthaler* N; *Heller 2844* C, N; *Robinson 359* V; *366* V; *380* V; Oahu, *Arnott* N; *Beechey* C; *Mann & Brigham 168* N; *Robinson 72* V; *120* V; *122* V; *184* V; *Safford 918* N; Kaala Mts., *Wilkes Expedition* N; Kauai, *Forbes 439* BM; Hawaiian Is., *Baldwin 37* C, N; *Miss Sessions* C; *Wilkes Expedition* C, N; ex Herb. John Donnell Smith N.

ASPLENIUM RHOMBOIDEUM Brack. Fil. U. S. Expl. Exp. 156. 1854

Asplenium stoloniferum Presl, Rel. Haenk. 1:44. 1825. Not Bory.
Asplenium fragile Presl, Hilleb. Fl. Haw. Is. 589. 1888.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: At elevations of 400–700 m., Hawaii and Maui.

ILLUSTRATIONS: Brack. Fil. U. S. Expl. Exp. *pl. 21. f. 2.* 1854; Presl, Rel. Haenk. 1: *pl. 6. f. 4.* 1825.

SPECIMENS EXAMINED: Hawaii, Mauna Kea, *Wilkes Expedition* N; Forest near Cape Lua Pele, *Wilkes Expedition* N; Maui, *Hillebrand* N; Hawaiian Is., *Baldwin* B, C, N; ex Herb. John Donnell Smith N.

A. rhomboideum is closely related to the South American *A. fragile* and to *A. viride* of N. Europe and Canada. It differs from both in the openness of the fronds and flabellate form of the pinnae as well as in size.

Kunze (Klotzsch, Linnaea **13**: 140. 1839) in describing *A. fragile* collected by Ehrenberg in Peru gives the length of the largest fronds as 2 in. He describes the habit as the same as that of *A. viride* and makes *A. castaneum* Schlect. (Linnaea **5**: 611. 1830) and *A. projectum* Kunze (Linnaea **9**: 68. 1834) synonyms. Diels, in E. & P. Nat. Pfl. 1^4: 235. 1899, gives *A. fragile* as a doubtful species, while he gives *A. castaneum* and *A.*

projectum true specific rank. Christensen (Ind. Fil.) gives the same treatment.

ASPLENIUM LUNULATUM Sw. Jour. Bot. Schrad. **1800**: 202. 1801

Asplenium erectum Bory, Willd. Sp. Pl. **5**: 328. 1810.

TYPE LOCALITY: South Africa.

DISTRIBUTION: Tropical countries.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; *Lichtenthaler* N; Maui, *Bailey* C; *Robinson 720* V; *721* V; Kauai, *Forbes 377* BM; *Heller 2845* C; *Knudsen 147* B; Hawaiian Is., *Baldwin 35* N; *Biddlesome* N.

ASPLENIUM MONANTHES L. Mant. 130. 1767

Asplenium monanthemum Murr. L. Syst. Nat. ed. 13. 785. 1774.
Asplenium Menziesii Hook. & Grev. Ic. Fil. *pl. 100.* 1829.
Asplenium leptophyllum Fée, Mém. Foug. 7. 50. *pl. 14. f. 2.* 1857.

TYPE LOCALITY: Cape of Good Hope.

DISTRIBUTION: At elevations of 900–1,800 m., South America, Northern Africa, the Azores, Madeira Islands, Hawaiian Islands.

ILLUSTRATIONS: J. E. Sm. Pl. Ic. Ined. *pl. 73.* 1790–91; Brack. Fil. U. S. Expl. Exp. *pl. 20. f. 2.* 1854; Fée, Mém. Foug. 7. *pl. 14. f. 2.* 1857; Hook. & Grev. Ic. Fil. *pl. 100.* 1829.

SPECIMENS EXAMINED: Maui, *Bailey* C; *Bishop 77* B; *Hillebrand* B; *Lichtenthaler* N; Kauai, *Knudsen 132* B; Oahu, *Diell* C; Hawaiian Is., *Baldwin 32* B, C; 1838–42; *Wilkes Expedition* N.

In the Berlin Herbarium there are two types of *A. monanthes*, one lax, spreading, with lobed pinnae, proliferous above, the other upright, taller, proliferous from lowest axils of pinnae, yet there is not enough difference to separate them as species.

ASPLENIUM TRICHOMANES L. Sp. Pl. 1080. 1753

Asplenium densum Brack. Fil. U. S. Expl. Exp. 151. 1854.

TYPE LOCALITY: Europe.

DISTRIBUTION: On rocks in temperate regions; on mountain sides in the tropics.

ILLUSTRATIONS: Brack. Fil. U. S. Expl. Exp. *pl. 20. f. 3, 3a.* 1854.

SPECIMENS EXAMINED: Maui, *Bailey* C; *Hillebrand* B; *Finsch 27* B; Oahu, Mt. Kaa, *Macrae* B; Hawaiian Is., *Baldwin* B, C; *Wilkes Expedition* B, C; *Lindley* C.

The difference between *A. densum* Brack. and the European *A. Trichomanes* L. consists in the fewer sori (never more than one row in the Hawaiian plant) and the more prominent wings upon the rachis, which suggests the question whether slight differences between plants widely separated geographically should be regarded as specific.

ASPLENIUM PAVONICUM Brack. Fil. U. S. Expl. Exp. 150. 1854

Asplenium normale Hilleb. Fl. Haw. Is. 588. 1888. Not Don.

TYPE LOCALITY: Saw Mill, Hawaii.

DISTRIBUTION: In moist, shady forests, Hawaiian Islands; rare.

ILLUSTRATION: Brack. U. S. Expl. Exp. *pl. 20. f. 1, 1a, 1b.*

SPECIMENS EXAMINED: Hawaii, *Wilkes 50465* N (type); Kilauea, *Lichtenthaler* N; Maui, *Bailey* C; *Lichtenthaler* N; Kauai, *Forbes 160* BM; *Heller 2771* C, N; *Knudsen 10* B; *Robinson 823* V; Oahu, *Heller 2218* C; *Safford 976* N; *977* N; Hawaiian Is., *Baldwin 33* C; *Lydgate* B; *Macrae* B; *Van Ingen* C; ex Herb. John Donnell Smith N; *Wilkes Expedition* B.

A. pavonicum is very nearly related to *A. normale* Don from Ceylon, but differs in the form of the pinnae and in size.

ASPLENIUM PSEUDO-FALCATUM Hilleb. Fl. Haw. Is. 597. 1888

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; *Robinson 628* V; *620* V; *279* V; *Wilkes Expedition* N; Maui, *Lichtenthaler* C; *Robinson 716* V; *710* V; ex Herb. John Donnell Smith N; Oahu, *Hillebrand* B; *Remy* B; *Robinson 144* V; *173* V; Hawaiian Is., ex Herb. Mt. Holyoke College C.

From the forms of *A. lobulatum* the pinnae of which are little divided, *A. pseudo-falcatum* is distinguished by its chartaceous texture in contrast to the coriaceous texture of *A. lobulatum.*

ASPLENIUM KAULFUSSII Schlect. Adumbr. 29. 1825

Asplenium protensum Kaulf. Enum. 167. 1824. Not Schlect.

Asplenium obtusatum Underw. in Heller, Minn. Bot. Stud. 1: 775. 1897. Not Forst.

TYPE LOCALITY: Oahu.

DISTRIBUTION: Higher forest regions, Oahu, Hawaii.

SPECIMENS EXAMINED: Hawaii, *Remy* B; *Baldwin* B; Oahu, *Anderson* B; *Forbes* BM; *Heller 2361* C; *Day* B; *Macrae* B; Kauai, *Robinson 843* V; Hawaiian Is., *Lydgate* B, C; ex Herb. John Donnell Smith *599* N; *Wilkes Expedition* N.

The sori are usually of the *Asplenium* type but in some cases diplazioid, while in others, the sori borne on adjacent veins face each other.

Asplenium kauaiense (Hilleb.) sp. nov.

Asplenium Mannii var. *kauaiense* Hilleb. Fl. Haw. Is. 595. 1888.

Asplenium obliquum Underw. in Heller, Minn. Bot. Stud. 1: 775. 1897. Not Forst.

TYPE LOCALITY: Kauai.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Kauai, *Knudsen 103* (type) B; *104* B; *105* B; *Heller 2486* C, N; Hawaiian Is., *Wilkes Expedition* N.

ASPLENIUM ENATUM Brack. Fil. U. S. Expl. Exp. 153. 1854

Asplenium lucidum Underw. in Heller, Minn. Bot. Stud. 1: 774. 1897. Not Forst.

TYPE LOCALITY: Kaala Mts., Oahu.

DISTRIBUTION: Hawaiian Islands.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 21. f. 1.* 1854.

SPECIMENS EXAMINED: Oahu, *Wilkes Expedition* N; Maui, *Bailey* C; *Bishop* B; *Lydgate* B, C; *Mann & Brigham 485* N; *Hillebrand* B; Kauai, *Forbes 53* BM; *Heller 2692* C, N; Kauai, *Van Ingen* C; *Robinson 840* V; Oahu, *Day 79* B; *Hillebrand* B; *Lichtenthaler* N; *Safford 871* N; *Wilkes Expedition* C, (type) N; Hawaiian Is., *Baldwin 38* C, N; *Miss Sessions* C; ex Herb. John Donnell Smith *38* N; *39* N; ex Herb. Mt. Holyoke College C.

ASPLENIUM HILLEBRANDII C. Chr. Ind. Fil. 115. 1905

Asplenium Mannii Hilleb. Fl. Haw. Is. 594. 1888. Not Hook.

TYPE LOCALITY: Waianae Range, Oahu.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Oahu, *Hillebrand* B, C; *Safford 917* N; Hawaiian Is., *Miss Sessions* C.

ASPLENIUM CONTIGUUM Kaulf. Enum. 172. 1824

TYPE LOCALITY: Oahu, Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Hawaii, *Mann & Brigham 160* N; Maui, *Hillebrand* B; *Robinson 325* V; *382* V; *712* V; *Wilkes Expedition* N; *Lichtenthaler* N; Kauai, *Knudsen 140* B; Oahu, *Bartsch 29* N; *Forbes* BM; *Heller 2115* C, N; *Mann & Brigham 156* N; *Safford 902* N; *903* N; *911* N; *Remy* B; *Wilkes Expedition* N; Molokai, *Hillebrand* B; Hawaiian Is., *Baldwin 40* B, C, N; *42* C; *Lindley* C.

ASPLENIUM CAUDATUM Forst. Prod. 80. 1786

Asplenium spathulinum Hilleb. Fl. Haw. Is. 604. 1888.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Tropical countries.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 22.* 1854.

SPECIMENS EXAMINED: Maui, *Hillebrand 13* B; *Robinson 632* V; Kauai, *Forbes 636* BM; *Knudsen 130* B; *137* B; *141* B; *142* B; *148* B; *149* B; Hawaiian Is., *Baldwin* B; *Gaudichaud* B.

Hillebrand, Fl. Haw. Is. 604. 1888, separates *Knudsen 141* and *148* as *A. spathulinum* on the basis that the pinnae in these specimens are more deeply incised than in the others. *Robinson 632* V shows both deeply cut and simply serrate leaves on the same plant.

Many of the segments are somewhat diplazioid, because sori arise on both sides of the initial vein and each extends along one of the forks.

ASPLENIUM NITIDULUM Hilleb. Fl. Haw. Is. 601. 1888

TYPE LOCALITY: Kauapali, W. Maui, Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Hillebrand* B (type); *Bailey* C; *Lichtenthaler* N; Oahu, *Heller 2055* C; Hawaiian Is., *Baldwin* N.

This is separated from *A. contiguum* on its firmer character and the acuminate apices of its pinnae in contrast to the lax and often recurving pinnae of the latter.

Heller 2055, though soriferous and apparently typical as to size and form of pinnae, has laciniate leaf blades on each plant that present the same ragged appearance that Hillebrand describes for *A. contiguum* var. *laciniatum*. Some of the specimens are diplazioid.

ASPLENIUM HORRIDUM Kaulf. Enum. 173. 1824

TYPE LOCALITY: Oahu.

DISTRIBUTION: In valleys above 500 m. elevation; South Pacific Islands and Hawaiian Islands.

ILLUSTRATION: Hook. Sp. Fil. 3: *pl. 193*.

SPECIMENS EXAMINED: Hawaii, *Remy* B; *Robinson 204* V; Maui, *Bishop 55* B; Oahu, *Anderson* B; *Forbes* BM; *Hillebrand* B; *Lichtenthaler* N; *Mann & Brigham 58* N; *Hillebrand* B; *Safford 908* N; *Wilkes Expedition* N; Kauai, *Heller 2853* C, N; *Knudsen 116* B; Hawaiian Is., *Baldwin 45* B, C, N; *Gaudichaud* B; *Wilkes Expedition* C, N; *Miss Sessions* C.

Asplenium glabratum sp. nov.

Rootstock short, scaly; leaves cespitose; leafstalk 25–50 cm. long, dull green to steel-blue, naked; blade 35–70 cm. × 11–20 cm., oblong, lanceolate, coriaceous, dull green; pinnae 5–10 cm. × 11–12 mm., oblong-lanceolate, cut into obliquely obovate, sometimes recurving lobes; veins flabellate; sori on the anterior vein in each lobe parallel to the midrib and also on other veins. *Asplenium horridum* var. B. Hilleb. Fl. Haw. Is. 604. 1888.

Asplenium horridum Kaulf. var. Underw. in Heller, Minn. Bot. Stud. 1: 774. 1897.

TYPE LOCALITY: Woods of Kahuku and Kahana, Oahu.

DISTRIBUTION: Oahu and Kauai, Hawaiian Islands.

SPECIMENS EXAMINED: Kauai, *Heller 2588* C (type), N; Hawaii, *Robinson 295* V; Oahu, *Hillebrand* B.

This species is distinguished from *A. horridum* Kaulf. by the smoothness and dull steel-blue color of its leafstalk and midrib, and by the greater number of sori which extend along the flabellate veins of the pinnae.

ASPLENIUM LOBULATUM Mett. in Kuhn, Linnaea **36**: 100. 1869

TYPE LOCALITY: Oahu, Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Hawaii, *Mann & Brigham 167* N; *Robinson 612* V; *707* V; *Wilkes Expedition* N; Maui, *Bailey* C; *Robinson 348* V; *371* V; Oahu, *Heller 2115* C, N; *Mann & Brigham 517* N; Oahu, *Robinson 138* V; *146* V; Kauai, *Van Ingen* C; *Miss Sessions* C.

The following specimens are diplazioid in certain pinnules: *Bailey* C; *Van Ingen* C; *Meyen* B; *Miss Sessions* C; *Wilkes Expedition* N.

ASPLENIUM VARIANS Hook. & Grev. Ic. Fil. *pl. 172.* 1830

TYPE LOCALITY: Nepal.

DISTRIBUTION: Japan, China, Ceylon, Africa, Hawaiian Islands.

ILLUSTRATION: Hook. & Grev. Ic. Fil. *pl. 172.* 1829.

SPECIMENS EXAMINED: Maui, *Lichtenthaler* N; *Baldwin 53* B, C, N; ex Herb. John Donnell Smith N.

Hooker and Greville state that this is not mentioned in Wallich's list of the plants in the herbarium of the East India Company, though he collected it at Nepal in 1818 and presented the type specimen to Dr. Hooker at Kew (Ms. Herb. Hook.).

ASPLENIUM MACRAEI Hook. & Grev. Ic. Fil. *pl. 217.* 1831

Asplenium strictum Brack. Fil. U. S. Expl. Exp. 168. 1854.
Asplenium erectum Macraei Hilleb. Fl. Haw. Is. 590. 1888.
Asplenium rhizophyllum Heller, Minn. Bot. Stud. 1: 775. 1897. Not Kunze.
Asplenium lunulatum var. C. Chr. Ind. Fil. 119. 1906.

TYPE LOCALITY: Oahu.

DISTRIBUTION: On ground in open woods, Hawaiian Islands.

ILLUSTRATION: Hook. & Grev. Ic. Fil. *pl. 217.* 1831.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; *Safford 99* N; Oahu, *Heller 2117* C, N; *Hillebrand* B; *Mann & Brigham 173* N; *Macrae* B; *Robinson 136* V; *139* V; *164* V; *Safford 897* N; *Wilkes Expedition* N; Kauai, *Forbes 390* BM; *2764* C, N; *Knudsen 110* B; *133* B; *145* B; *146* B; *148* B; *Lichtenthaler* N; *Wilkes Expedition* N; Hawaiian Islands, *Baldwin 36* C; *Miss Sessions* C; ex Herb. John Donnell Smith N; *Wilkes Expedition* C, N.

Hillebrand's *Asplenium erectum e myriophyllum* doubtless be-

longs here. *Heller 2764*, *Knudsen 145*, *Baldwin 36*, and *Gaudichaud* (B) conform to the *e* type, which has slender, spaced pinnules, while *Heller 2117* and *Heller 2764* have both open and the compact forms of leaf upon the same plant. Occasionally a sorus is diplazioid.

Hillebrand describes *A. erectum* as having a smooth rachis, while *A. Macraei* has a winged rachis.

The original description of *A. lunulatum* (Sw. Jour. Bot. Schrad. 1800[2]: 52. 1801) gives the pinnae as rhomboid, ovate, crenulate; the African specimens are simply pinnate, the pinnae being auricled.

ASPLENIUM LYDGATEI Hilleb. Fl. Haw. Is. 596. 1888

TYPE LOCALITY: Niu, Oahu.

DISTRIBUTION: Known from type locality only.

The plant is represented at Berlin by two specimens collected by Lydgate in 1871.

Asplenium Goldmannii Underw. in herb., nom. nov.

Tarachia polyphylla Presl, Epim. 83. 1849.

Asplenium polyphyllum Hilleb. Fl. Haw. Is. 607. 1888. Not Bert.

TYPE LOCALITY: Oahu, Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands.

ILLUSTRATION: Mett. Aspl. *pl. 5. f. 23.* 1859.

SPECIMENS EXAMINED: Oahu, *Baldwin 51a* B, C; *Forbes* BM; *Wilkes Expedition* N; *Lydgate* B; Hawaiian Islands (collector unknown) C.

ASPLENIUM ACUMINATUM Hook. & Arn. Bot. Beech. 106. 1832

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Bailey* C; *Baldwin 51b* B; *51c* B; *Hillebrand* C; *Robinson 376* V; Oahu, *Forbes* BM; *Hillebrand* B; *Robinson 149* V; *151* V; *186* V; *Wilkes Expedition* N; *Lichtenthaler* N; Kauai, *Forbes 85* BM; *140* BM; *Robinson 428* V; *479* V; *488* V; *497* V; *702* V; Hawaiian Islands, *Baldwin 51* C, N, C; *Mann & Brigham 494* N; *Wilkes Expedition* N; ex Herb. John Donnell Smith N.

Asplenium rhipidoneuron nom. nov.

Asplenium furcatum Hilleb. Fl. Haw. Is. 604. 1888. Not Thunb.

TYPE LOCALITY: Haleakala, Maui.

DISTRIBUTION: Hawaiian Islands.

ILLUSTRATION: Hook. & Grev. Ic. Fil. *pl. 189.* 1831.

SPECIMENS EXAMINED: Hawaii, *Baldwin 50* B, C, N; *Wilkes Expedition* N; Maui, *Bailey* C; *Baldwin 44* (type) B, C, N; *Robinson 353* V; *392* V; *796* V; *Wilkes Expedition* N; Oahu, *Mann & Brigham 261* N; *Wilkes Expedition* N; Kauai, *Forbes 58* BM; *Heller 2872* C, N; *Van Ingen* C; Hawaiian Islands, *Baldwin 49* C; *Wilkes Expedition* C.

A. rhipidoneuron may be separated into two forms.

Pinnae under 4 cm. long, rhombic.
Pinnae 6–15 cm. long, acuminate.

This will scarcely separate them as two species, but it is interesting as it suggests the possible crossing of *A. lobulatum* and *A. cuneatum.*

ASPLENIUM INSITICIUM Brack. Fil. U. S. Expl. Exp. 161. 1854

Asplenium cristatum Brack. Fil. U. S. Expl. Exp. 163. 1854. Not Lam.

TYPE LOCALITY: Hawaiian Is., in forests.

DISTRIBUTION: Hawaiian Is., Philippine Is., New Caledonia.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 22. f. 2.* 1854.

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition* N; *Mann & Brigham* N; Maui, *Bailey* C; *Hillebrand* B; *Lichtenthaler* N; Waiopua, *Lichtenthaler* N; Oahu, *Baldwin* B; *Forbes* BM; *Heller 2310* C, N; *Hillebrand* B; Nuuanu, *Robinson 142* V; *Hillebrand* B; Hawaiian Is., *Baldwin 41* C; *43* C, N; *Wilkes Expedition* N; ex Herb. John Donnell Smith N.

A. insiticium Brack. is a more delicate fern than *A. lobulatum.*

The following specimens are diplazioid: *Asplenium insiticium grandipinnatum* Hillebrand B; *Asplenium insiticium pseudonitidum* Hillebrand B.

ASPLENIUM CUNEATUM Lam. Encyc. 2: 309. 1786

TYPE LOCALITY: Jamaica, B. W. I.

DISTRIBUTION: West Indies, Philippine, Fiji, Samoan, and Hawaiian Islands.

ILLUSTRATIONS: Sloane, Hist. Jam. 1: 46. *f.* 2. 1707. Brack. Fil. U. S. Expl. Exp. *pl. 21.* 1854.

SPECIMENS EXAMINED: Maui, *Robinson 344* V; *702* V; Kauai, *Heller 2865* C, N; ex Herb. John Donnell Smith N.

This differs from *A. insiticium* in texture and color and is smaller than the average specimen of the latter, though their dimensions overlap.

ASPLENIUM PARALLELUM Baker, Hook. & Baker, Syn. Fil. 486. 1874

Asplenium bipinnatum Hilleb. Fl. Haw. Is. 595. 1888.

TYPE LOCALITY: Niu, Oahu.

DISTRIBUTION: Known from type locality only.

SPECIMENS EXAMINED: Hillebrand B.

This plant is represented by one sheet labelled *Asplenium flaccidum* which is placed with *Asplenium Lydgatei*, at Berlin. It differs from *A. Lydgatei* in being more sturdy in habit and firmer in texture.

ASPLENIUM PATENS Kaulf. Enum. 175. 1824. Not Hook. & Arn. Not Gaud.

TYPE LOCALITY: Oahu.

DISTRIBUTION: Hawaiian Islands.

ILLUSTRATION: Hook. Sp. Fil. 3. *pl. 203.* 1860.

SPECIMENS EXAMINED: Oahu, *Hillebrand* B; Maui, *Hillebrand* B, K; *Lydgate B.*

This rare species resembles *A. cuneatum* in habit in spite of its larger size and tripinnate divisions.

ASPLENIUM ADIANTUM-NIGRUM L. Sp. Pl. 1081. 1753

A. patens Gaud. Voy. Freyc. Bot. 320. 1828. Not Kaulf.

TYPE LOCALITY: Southern Europe.

DISTRIBUTION: Tropical countries.

SPECIMENS EXAMINED: Hawaii, *Lichtenthaler* N; *Mann &*

Brigham 259 N; District of Waimea, *Wilkes Expedition* N; Mauna Kea, *Wilkes Expedition* N; Mauna Loa, *Wilkes Expedition* N; Maui, *Hillebrand* B; Haleakala, *Hillebrand* B; *Finsch 8* B; *Wilkes Expedition* N; *Bailey* C; Kauai, *Knudsen* B; *Wilkes Expedition* N; Hawaiian Islands, *Baldwin 48* B, C, N, V; *Gaudichaud* B; *Wilkes Expedition* B, C; *Douglas* B; *Hillebrand* B; ex Herb. John Donnell Smith N.

Gaudichaud's specimen in the Berlin Herbarium is labelled "Forma acutum Bory, var. Onopteris L.," but the plant is not distinguishable by dentation or by other characteristics from other specimens of *A. Adiantum-nigrum*.

ASPLENIUM VEXANS Heller, Minn. Bot. Stud. 1: 776. 1897

TYPE LOCALITY: Slopes of Konahuanui, above Manoa, Oahu.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Oahu, *Heller 2058* (type) C; *Robinson* V; *Baldwin* V.

ASPLENIUM SCHIZOPHYLLUM C. Ch. Ind. Fil. 131. 1905. Not Sw.

A. dissectum Brack. Fil. U. S. Expl. Exp. 170. 1854. Not Sw.

TYPE LOCALITY: Hawaii.

DISTRIBUTION: On ground and on trees, Hawaiian Islands.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 24*. 1854.

SPECIMENS EXAMINED: Hawaii, *Baldwin 51d* B, C; *Hillebrand* B, C; *Lydgate* B; Maui, *Hillebrand* B; Oahu, *Wilkes Expedition* N; Kauai, *Forbes 361* BM; *Heller 2765* C, N; *Knudsen 113, 115* B; *Johnson* B; Hawaiian Islands, *Baldwin 49* N; *Wilkes Expedition* N.

ASPLENIUM SPHENOTOMUM Hilleb. Fl. Haw. Is. 599. 1888

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: In forests at 1,300–1,600 m. elevation, Hawaiian Islands.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; Maui, *Baldwin 52* B; Kauai, *Forbes 339* BM; *420* BM; *Knudsen 108* B; *117* B; Hawaiian Islands, *Baldwin 52* N.

SPECIES INQUIRENDAE

ASPLENIUM PELLUCIDUM Lam. Encyc. 2: 305. 1786

TYPE LOCALITY unknown.

DISTRIBUTION: Malaysia-Polynesia.

SPECIMENS EXAMINED: Ex Herb. Kunth; *Meyen* B.

One specimen with auricled pinnae 52-jugate, and corresponding in other respects to *A. pellucidum* Lam. is in the Berlin Herbarium and was originally in Kunth's Herbarium given by Dr. Meyen in 1833. The specimen is no doubt correctly named but correctness of the locality seems doubtful.

ASPLENIUM MEIOTOMUM Hilleb. Fl. Haw. Is. 596. 1888

TYPE LOCALITY: Wailupe, Oahu.

DISTRIBUTION: Known from type locality only.

SPECIMENS EXAMINED: *Hillebrand* B.

This is represented by a single sterile specimen at Berlin, but Hillebrand's description proves that this is not his entire collection of the plant. It may be a teratological form.

ASPLENIUM KNUDSENII Hilleb. Fl. Haw. Is. 601. 1888

No specimen so labelled or corresponding to Hillebrand's description was found in the Berlin Herbarium.

27. ATHYRIUM Roth, Mag. Bot. Roem. & Ust. 2[1]: 105. 1799

Rootstock short, suberect; leafstalks non-articulate, basal scales usually thin-walled; blades thin, herbaceous, 1–3-pinnate; veins free; vascular bundles of leafstalk in two strands at base, uniting above; sori linear or curving across the vein, or roundish at the end of a vein; indusia corresponding with the sorus in shape, or rarely absent.

Leafblades bipinnatifid.
- Sori on distal portion of veins but not protruding beyond margin of lobe. *A. deparioides.*
- Sori protruding beyond the margin of the lobe, in some cases apparently stipitate. *A. proliferum.*

Leafblades tripinnate to quadripinnate.
- Sori medial upon veins; ultimate divisions of pinnule oblong. *A. Poiretianum.*
- Sori along distal portions of veins; ultimate divisions of pinnule linear. *A. Baldwinii.*

ATHYRIUM DEPARIOIDES (Brack.) Christ, p. p. Farnkr. Erde 223. 1897

[Excl. description and figures]

Asplenium deparioides Brack. Fil. U. S. Expl. Exp. 172. 1854
Athyrium proliferum C. Chr. p. p. Ind. Fil. 145. 1905.

TYPE LOCALITY: Kaala Mts., Oahu.

DISTRIBUTION: Hawaiian Islands.

SPECIMENS EXAMINED: Oahu, *Baldwin* B; *Baldwin 77* B; *Forbes* BM; *Hillebrand* B; *Lydgate* B; Kauai, *Forbes 32* BM; *Forbes 215* BM; *Forbes 238* BM; *Heller 2303* C; *Heller 2690* C; *Baldwin 47b* C; Hawaiian Is., *Baldwin 47* C.

ATHYRIUM PROLIFERUM (Kaulf.) C. Chr. p. p. 145. 1905

Dicksonia prolifera Kaulf. Enum. 225. 1824.
Deparia Macraei Hook. & Grev. Ic. Fil. *pl. 154*. 1829.
Cibotium proliferum Presl, Tent. Pterid. 69. 1836.
Asplenium deparioides var. *y*, Hilleb. Fl. Haw. Is. 615. 1888.
Athyrium deparioides Christ, p. p. Farnk. Erde 223. 1897.
Deparia triangularis Underw. in Heller, Minn. Bot. Stud. 1: 778. 1897.

TYPE LOCALITY: Oahu.

DISTRIBUTION: In wet woods, 300–600 m. elevation, Hawaiian Islands.

ILLUSTRATIONS: Hook. & Grev. Ic. Fil. *pl. 154*. 1829; Christ; Farnk. Erde 223. 1897.

SPECIMENS EXAMINED: Oahu, *Baldwin* B; *Beechey* C; *Brackenridge* N; *Forbes* BM; *Lichtenthaler* N; Kauai, *Heller 2740* C, *Heller 2057* C.

ATHYRIUM POIRETIANUM (Gaud.) Presl, Tent. Pterid. 98. 1836

Asplenium Poiretianum Gaud. Voy. Freyc. Bot. 321. *pl. 13*. 1832.
Allantodia scandicinum Kaulf. Enum. 179. 1836.
Asplenium scandicinum Underw. in Heller, Minn. Bot. Stud. 1: 775. 1897. Not Presl.

TYPE LOCALITY: Oahu.

DISTRIBUTION: In wet forests, at altitudes of 200–300 m., Hawaiian Islands.

ILLUSTRATION: Gaud. Voy. Freyc. Bot. *pl. 13*. 1832.

SPECIMENS EXAMINED: Hawaii, Robinson *616* V; *625* V; Maui, *Bailey* C; *Finsch* B; *Hillebrand* B; *Robinson 715* V; Oahu, *Chamisso* B; *Diell* C; *Forbes* BM; *Hillebrand 27* B; *Macrae* B; *Meyen* B; Kauai, *Heller 2623* C; *Hillebrand 118a* B; Hawaiian Is., *Baldwin 53* B, C; *Gaudichaud* (type) B; *Miss Sessions* C; *Wilkes Expedition* C.

ATHYRIUM BALDWINII (Hilleb.) C. Chr. Ind. Fil. 140. 1905

Asplenium Baldwinii Hilleb. Fl. Haw. Is. 618. 1888.

TYPE LOCALITY: Kauai.

DISTRIBUTION: High altitudes, Kauai.

SPECIMENS EXAMINED: Kauai, *Bailey* C; *Baldwin 54* (type) B, C, K; *Forbes 125* BM; *240* BM; *Robinson 402* V; *426* V; *458* V; *461* V; *464* V.

The sori are subapical in this species and a fibrillose scale appears at the base of almost every pinna, while the sori of *A. Poiretianum* are typically medial or proximal upon the veins.

28. DIPLAZIUM Sw. Jour. Bot. Schrad. **1800**[2]: 61. 1801

Rootstock short, creeping or suberect; leafblades simple to quadripinnatifid; basal scales of leafstalk clathrate, with or without glands; vascular bundles two at the base of leafstalk uniting above; veins free, once to several times forked; sori linear, indusiate, often double, the indusium opening as in *Asplenium*.

Type species: *Diplazium plantaginifolium* (L.) Sw.

The Hawaiian species of *Diplazium* form a very natural group, more firm in texture and coarser in habit than the species of *Athyrium*, hence it seems better on account of the limitations of this paper to follow Diels (Eng. & Prantl, Nat. Pflanzenfam. **1**[4]: 224. 1902) than to place these plants in the genus *Athyrium*, following Milde (Bot. Zeit. **24**: 373. 1866) and Copeland (Philipp. Jour. Sci. **3**: (Bot.) 285. 1908).

Leaves pinnate; rootstock erect or creeping; leafstalks more or less paleaceous at base, with non-glandular scales.
  Rootstock erect; leafstalks stout, dull green, dark brown in drying; basal scales few, light brown; leafblade ovate-lanceolate, 15–30 cm. long, membranous; middle pinnae linear-lanceolate, 12.5–15 cm. × 7–22 mm.; basal pinnae reduced, the lowest auricled. *D. marginale.*
  Rootstock creeping; leafstalks slender, stramineous; basal scales dark brown.

Basal scales of leafstalks persistent, numerous; leafblade 45–75 cm. long; middle pinnae linear-lanceolate, falcate; basal pinnae reduced. *D. Fenzlianum.*

Basal scales of leafstalk few, caducous; leafblade 15–30 cm. long; middle pinnae oblong-lanceolate, truncate at the base and parallel to the rachis above, oblique below; basal pinnae not reduced. *D. molokaiense.*

Leaves bipinnate to tripinnate; rootstock creeping; leafstalks paleaceous with glandular scales at base when young, glabrate with age.

Leafblade deltoid or ovate-deltoid, light green, deeply tripinnatifid; pinnae oblong-lanceolate; lower pinnae 5–7.5 cm. distant; pinnules lanceolate. *D. Arnottii.*

Leafblade ovate-oblong, dark green, tripinnate; lower pinnae 12.5–15 cm. distant; pinnules oblong-lanceolate. *D. sandwichianum.*

DIPLAZIUM MARGINALE (Hilleb.) C. Chr. Ind. Fil. 235. 1905

Asplenium marginale Hilleb. Fl. Haw. Is. 613. 1888.

TYPE LOCALITY: Molokai.

DISTRIBUTION: Lower forests, Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Lydgate* B; Molokai, *Hillebrand* (type) B; Oahu, *Baldwin 47a* B; *47b* B; Kauai, *Knudsen 151* B.

DIPLAZIUM FENZLIANUM (Luers.) C. Chr. Ind. Fil. 232. 1905

Asplenium Fenzlianum Luerssen in Wawra, Flora **58**: 434. 1875.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: In isolated localities, Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Bailey* C; Oahu, *Baldwin* B; *Hillebrand* B; *Lydgate* B; Molokai, *Hillebrand* B; Hawaiian Is., *Hillebrand* B.

Diplazium molokaiense nom. nov.

Asplenium arboreum Hilleb. Fl. Haw. Is. 609. 1888. Not Willd.

TYPE LOCALITY: Molokai, Hawaiian Islands.

DISTRIBUTION: In wet gulches, Hawaiian Islands.

SPECIMENS EXAMINED: Molokai, *Baldwin 46* B; *Hillebrand* (type) B; Oahu, *Baldwin* B; Kauai, *Forbes 438* BM; *Knudsen 102* B.

DIPLAZIUM ARNOTTII Brack. Fil. U. S. Expl. Exp. 144. 1854

Asplenium diplazioides Hook. & Arn. Bot. Beech. 107. 1832. Not Bory.

Asplenium Arnottii Baker in Hook. & Baker, Syn. Fil. 240. 1867.

Athyrium Arnottii Milde, Bot. Zeit. **28**: 371. 1870.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Lower forests, Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Bailey* C; Molokai, *Hillebrand* B; Oahu, *Beechey* C; *Beratz* B; *Forbes* BM; *Heller 2900* C; *Hillebrand* B; Kauai, *Johnson* B; Hawaiian Is., *Baldwin 55* C; *56* B, C; *57* C; *Mrs. Gulick* C; ex Herb. Kewensis C.

Though the rootstock is prostrate, this fern has almost the appearance of an arborescent form, the leaves reaching a height of from five to six feet.

The Hawaiians prize the tips of the young fronds as a salad.

DIPLAZIUM SANDWICHIANUM (Presl) Diels, in E. & P. Nat. Pflanzenfam. 1^4: 228. 1899

Athyrium sandwichianum Presl, Tent. Pterid. 98. 1836.

Asplenium sandwichianum Hook. Sp. Fil. **3**: 225. 1860.

Asplenium brevisorum Baker, in Hook. & Baker, Syn. Fil. Ed. 2. 228. 1874.

TYPE LOCALITY: Oahu, Hawaiian Islands.

DISTRIBUTION: Hawaiian Islands, Peru.

SPECIMENS EXAMINED: Hawaii, *Beratz* B; *Robinson 620* V; Maui, *Hillebrand* B; *Robinson 386* V; Molokai, *Hillebrand* B; Oahu, *Diell* C; *Forbes* BM; *Heller 2073* C; *Macrae* C; *Meyen* B (cotype); *Robinson 148* V; *156* V; *160* V; Hawaiian Is., *Baldwin* B; ex Herb. Mt. Holyoke College C; *Wilkes Expedition* C.

SPECIES INQUIRENDA

DIPLAZIUM SANDWICHENSE Presl, Epim. 85. 1850–52

From Presl's description this seems to be a form very closely related to *Diplazium molokaiense*, differing from it in the deeper cutting of the lobes and the greater length of the auricle.

Meyen's type is doubtless still in Presl's Herbarium in the Bohemian University at Prague. There seems to have been no further collection of the plant.

29. SADLERIA Kaulf. Enum. 162. 1824

Sadleria, an endemic Hawaiian genus, is frequently found as a pioneer on disintegrating lava rock. It differs conspicuously in

its greater size, rigidity, and the number of its scales, from *Blechnum*, with which Brackenridge and Gaudichaud united it on the basis of the similarity of its sori.

Caudex erect, often arborescent, more or less clothed with scales, or "pulu"; leaves bipinnatifid to bipinnate, 60–180 cm. long in arborescent species, 25–50 cm. in herbaceous forms, usually coriaceous; sori linear upon the intercostal arches on either side of, and parallel to, the midrib of the pinnule, covered by a coriaceous indusium; sporangia short-stalked.

Type species: *Sadleria cyatheoides* Kaulf.

Caudex arborescent, 60–300 cm. in height.
- Leafstalk scaly at base, naked or slightly furfuraceous above; sori usually extending nearly the length of the segment.
  - Leafstalk 60–90 cm. long, sulcate, densely clothed at base with light brown scales, 3–4 cm. × 5 mm., slightly chaffy above; blades chartaceous to subcoriaceous, furfuraceous when young, nearly glabrate when mature, oblong-lanceolate, 150–200 cm. long, bipinnate; pinnae linear, 30–60 cm. × 4–7.5 cm.; pinnules 3 mm. apart. *S. Souleytiana.*
  - Leafstalk 30–60 cm. long, not sulcate, paleaceous at the base with scales 4–5 cm. × 3 mm., naked above; blades coriaceous, glabrate, ovate-oblong, 60–90 cm. long, bipinnatifid; pinnae linear-lanceolate, 15–20 cm. × 1.5–2 cm.; segments of pinnae 2 mm. apart. *S. cyatheoides.*
- Leafstalk scaly throughout, 20–45 cm. long, sulcate; basal scales ribbed, and revolute, upper scales ribless, chaffy; blades coriaceous, oblong, acuminate, 45–60 cm. long, bipinnatifid; pinnae oblong, falcate, 10–16 cm. × 15 mm., chaffy along the midrib; sori usually not as long as the segment, often less than half as long. *S. Hillebrandii.*

Caudex not arborescent, 2–15 cm. in height; leafstalk densely paleaceous as are midribs and costae.
- Leafstalk 15–25 cm. long; scales dark brown, 10–15 cm. long; blades coriaceous, oblong-lanceolate, 25–50 cm. long, pinnae 5–10 cm. × 12–25 mm.; pinnules crowded; margins crenulate. *S. polystichoides.*
- Leafstalk 12–15 cm. long; scales reddish brown, 6–10 cm. long; blades subcoriaceous, ovate-lanceolate, 28–30 cm. long; pinnae 2–4 cm. × 0.75–1 cm., reduced below, not crowded; margins entire. *S. unisora.*

SADLERIA SOULEYTIANA (Gaud.) Moore, Ind. Fil. 26. 1857

Blechnum Souleytianum Gaud. Voy. Bonite Bot. *pl. 2. f. 7, 8; pl. 134.* 1846–49.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Common in deep wet woods at high elevations Hawaiian Islands.

ILLUSTRATIONS: Gaud. Voy. Bonite Bot. *pl. 2. f. 7, 8. pl. 134.* 1846–49.

SPECIMENS EXAMINED: Maui, *Bailey* C; Kauai, *Heller 2807* C; N; Oahu, *Forbes* BM; *Hillebrand* B; Lanai, *Hillebrand* B; Hawaiian Islands, *Baldwin 24* C; N.

SADLERIA CYATHEOIDES Kaulf. Enum. 162. 1824

Blechnum Fontanesianum Gaud. Voy. Freyc. Bot. 397. *pl. 15.*
Sadleria pallida Hook. & Arn. Bot. Beech. 75. 1832.
Blechnum pallidum Brack. Fil. U. S. Expl. Exp. 133, in part, 1854.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Lower elevations, Hawaiian Islands and Sumatra.

ILLUSTRATION: Gaud. Voy. Freyc. Bot. *pl. 15.*

SPECIMENS EXAMINED: Hawaii, *Wilkes Expedition 12* C, N; *13* C, N; Maui, *Bailey* C; Oahu, *Chamisso* B; *Freycinet* K; *Gaudichaud* B; *Hillebrand* B; *Lichtenthaler* N; *Macrae* C; *Mann & Brigham 188* N; *Safford 866* N; *867* N; *868* N; ex Herb. Copeland N; Kauai, *Forbes 40* BM; Hawaiian Islands, *Baldwin 23* B, N; *Miss Sessions* C; ex Herb. John Donnell Smith N.

Chamisso's type in the Berlin herbarium consists of two sheets: (1) Leafstalk 15 cm. long with rigid scales at base, blade 18-jugate, 23 cm. wide; (2) fragment without apex, 16-jugate; slightly wider.

Sadleria Hillebrandii nom. nov.

Sadleria pallida Hilleb. Fl. Haw. Is. 582. 1888. Not Hook. & Arn. Bot. Beech. 75. 1832.
Blechnum pallidum Brack. Fil. U. S. Expl. Exp. 133, in part. 1854.

TYPE LOCALITY: Kauai, *Hillebrand 80* (Herb. Kgl. Bot. Gart. Berlin).

DISTRIBUTION: In dry, exposed places, Hawaiian Islands.

ILLUSTRATION: PLATE 11.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; Maui, *Bailey* C; Oahu, *Hillebrand 83* B; *Robinson 14* V; *19* V; Kauai, *Hillebrand 80* (type) B; *Heller 2866* C, N.

Sadleria pallida Hook. & Arn. proves to be a synonym of

Sadleria cyatheoides Kaulf. The plants confused under this name by Brackenridge, Hillebrand, and most later writers form a distinct species, here named for Hillebrand, since he has most fully described it.

This species is one of the first to gain a foothold upon the lava in the floors of the old craters and is very resistant to dry winds on exposed bluffs.

SADLERIA POLYSTICHOIDES (Brack.) Heller, Minn. Bot. Stud. 1: 788. 1897

Blechnum squarrosum Gaud. Voy. Bonite Bot. *pl. 2. f. 1, 6.* 1846–49. Without description.

Blechnum polystichoides Brack. Fil. U. S. Expl. Exp. 134. 1854.

Sadleria squarrosa Hilleb. Fl. Haw. Is. 582. 1888.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: In forests on lower slopes of mountains, Hawaiian Islands.

ILLUSTRATIONS: Gaud. Voy. Bonite Bot. *pl. 2. f. 1, 6.* 1846–49.

SPECIMENS EXAMINED: Hawaii, *Lichtenthaler* N; *Wilkes Expedition* N; Oahu, *Forbes* BM; *Hillebrand* B; *Lydgate* B; *Heller 2392* C, N; Molokai, *Hillebrand* B; Kauai, *Forbes 216* BM; Hawaiian Islands, *Gaudichaud* B; *Baldwin 25* B, C, N.

Sadleria unisora (Baker) comb. nov.

Polypodium unisorum Baker; Hook. & Bak. Syn. Fil. 307. 1867.

Gymnogramme sadlerioides Underw. in Heller, Minn. Bot. Stud. 1: 781. 1897.

Sadleria squarrosa var. *depauperata* Hilleb. Fl. Haw. Is. 583. 1888.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: On rocky walls of high plateaus, Hawaiian Islands.

ILLUSTRATIONS: Underw. in Heller, Minn. Bot. Stud. 1: *pl. 43.* 1897. PLATE 12.

SPECIMENS EXAMINED: Kauai, *Hillebrand* B; *Forbes 445* BM; *Heller 2863* C; N.

This is undoubtedly a valid species, rather than an ecological "variety" of *S. polystichoides*, as it has been termed by Hillebrand (Hilleb. Fl. Haw. Is. 583. 1888), for true *S. polystichoides* grows in

the neighborhood of Kilauea, under conditions apparently as xerophytic as those under which *S. unisora* is found.

30. DOODIA R. Br. Prod. Fl. N. Holl. 151. 1810

Rootstock short, oblique; leaves clustered, pinnatifid to pinnate, coriaceous; leafstalk scaly; veins connected by one or more arches parallel to the midrib; sori oblong or slightly curved, in one or more rows parallel to the midrib; indusium membranaceous, opening toward the midrib.

Type species: *Doodia aspera* R. Br.

DOODIA KUNTHIANA Gaud. Voy. Freyc. Bot. 401. 1829

Doodia media Hilleb. Fl. Haw. Is. 584. 1888. Not R. Br.
Doodia media var. C. Chr. Ind. Fil. 242. 1905.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Common on banks of streams or in wet woods at 500–900 m. altitude; Hawaiian Islands.

ILLUSTRATION: Gaud. Voy. Freyc. Bot. *pl. 14.*

SPECIMENS EXAMINED: Hawaii, *Robinson 230* V; *241* V; Maui, *Robinson 305* V; *318* V; *350* V; Oahu, *Baldwin* N; *Macrae* B; *Robinson 74* V; *Safford 895* N; *Wilkes Expedition* N; Kauai, *Forbes* BM; *252* BM; *Heller 2601* C, N; *Van Ingen* C; *Robinson 803* V; *809* V; Hawaiian Islands, *Baldwin 26* B, C, N; *Baldwin 27* B, C; *Gaudichaud* B, C; *Miss Sessions* C; ex Herb. J. Donnell Smith N.

This species has been confused by Hillebrand and others with *D. media* R. Br. (type from Australia), the lower pinnae of which become reduced to small triangular auricles. It is safer to maintain the species as distinct under Gaudichaud's name. An allied species with widely spaced pinnae, collected in the Fiji Islands by Capt. Wilkes, is mentioned by Brackenridge (Fil. U. S. Expl. Exp. 138. 1854) as a "var. B."

Mr. C. N. Forbes's *D. Kunthiana* var. *depauperata* (*252* BM), collected "on rocky ledges along the main Wahiawa," is so much smaller than the other plants of *D. Kunthiana* as to have an entirely different appearance. However, as to the form of the leaf, pinnate below, pinnatifid in the upper half, and the form of the linear-lanceolate scales, they are similar. These small plants are fine fruiting condition.

The development of the embryo-sac of Arisaema triphyllum

F. L. Pickett

(with plates 13 and 14)

The development of the embryo-sac of *Arisaema triphyllum* was first studied by Strasburger (1) in 1879, and later by Mottier (2), who published his observations in 1892. Campbell (3, 4) in his studies on the Araceae has referred to the findings of Mottier and used them as a basis for comparison. Gow (5), in his introduction to the study of the embryogeny of *Arisaema triphyllum*, reviewed the development of the embryo-sac, confirmed the findings of the second study mentioned above, and added observations of the division of a primary archesporial cell to form embryo-sac initials. The writer has been able, after the examination of several hundred ovules, to verify most of the stages in the embryo-sac development as set forth in the above-mentioned articles; but has found some notable points of difference touching the formation of megaspores from the primary archesporial cell. On the other hand the writer has found that in some respects the development of *Arisaema triphyllum* agrees very closely with that of *Symplocarpus foetidus* as shown by Rosendahl (6) in 1909.

The material for the present study was collected in proper season through four years, 1909–12. The various stages were secured from as many habitat conditions as possible. All fixing was done in the field or immediately after the return to the laboratory. Parts of young spikes and separate pistillate flowers of older spikes were fixed, some in strong chrome-acetic acid mixture, and others in chrome-osmic-acetic acid mixture, for 24–30 hours, then washed in running water for 24 hours, and finally gradually dehydrated. The blackening from osmic acid was in some cases removed by treatment of the whole specimens with hydrogen peroxide; but this resulted in considerable shrinkage, so that the specimens were of very little value. The sections were stained with safranin-gentian violet-orange G, with occasional special staining of cell walls with Bismarck brown.

OVULE AND MEGASPORE MOTHER CELL

The ovules occur in groups of two to six arising from the basal placenta in each ovary. As it first appears, each ovule is a rounded conical mass of cells covered by a clearly marked epidermal layer, but otherwise undifferentiated (FIG. 4). Soon after the ovule has reached the stage shown in FIG. 4, or about the time of the appearance of the inner integument, the primary archesporial cell, or megaspore mother cell or cells, may be found at the apex of the nucellus beneath the epidermis. These cells are hypodermal in origin, and are clearly differentiated from surrounding cells by their greater size, denser cytoplasm, and larger nuclei. The time of the differentiation of the sporogenous cells is only approximately the same as that of the development of the first integument as will be seen by a comparison of FIG. 1, 2, 3, 6, 8. FIG. 1 and 2 show two and three clearly differentiated megaspore mother cells, and FIG. 6 one such cell with complete periclinal divisions of the epidermal cells, while the integument in each of these ovules shows less growth than in FIG. 3 where no such cell can be with certainty distinguished. From one to four megaspore mother cells have been observed in a single nucellus (FIG. 1, 7, 8, 9, 11). These are usually in the hypodermal layer at first, although in a few instances some were beneath that (FIG. 2, 11, 19). The cells in FIG. 11 and 19 have been removed from the surface by periclinal division of epidermal cells. In every specimen examined the megaspore mother cells were contiguous, but in no case was there found direct evidence that they had been formed by a division of a primary archesporial cell as suggested by Mottier (2, p. 259), and by Gow (5, p. 40). The position of the cells in FIG. 19 and of the two cells at the left in FIG. 11 indicates that such an origin is possible; but the failure to find other than very rare cases of nuclear activity in cells which have not arisen by the division of epidermal cells discredits the probability of such an origin. The only form of nuclear activity found in clearly differentiated sporogenous cells was the synaptic or later stages in the tetrad division. The fact that in different ovules showing the same general structure, more than one megaspore mother cell may be found, suggests the origin of such multiple sporogenous cells by simultaneous differentiation from hypodermal cells (see FIG. 1, 2, 8). That

the division of a primary archesporial cell to form two or more megaspore mother cells or embryo-sac initials is not universal, or even regular, is proven by the presence of many ovules showing the development of but one tetrad of potential megaspores or but one embryo-sac, without evidence of other crushed or damaged initial cells (FIG. 17, 18, 22, 23, 24). Fig. 7, 9, 13 show cross sections of the nucellus with the megaspore mother cells variously arranged.

THE TETRAD OF MEGASPORES

As the inner integument grows and incloses the nucellus, and the outer integument appears, the megaspore mother cells increase in size, and the epidermal cells of the nucellus undergo periclinal division. This periclinal division, shown at its beginning in FIG. 2 and 5, takes place more rapidly at the apex, sometimes forming a layer of four cells above the megaspore initials (FIG. 16, 18, 22). The division of lateral cells is also irregular and results in a final covering one to three layers of cells in thickness (FIG. 10, 11, 24). During these changes in the size and form of the ovule, the megaspore mother cells increase rapidly in size, becoming somewhat broader and much longer than the surrounding cells. Nuclear changes are also evident, and by the time the outer integument is well started most of the nuclei of the megaspore mother cells show either synapsis or closely related conditions preparatory to the first tetrad division (FIG. 7, 9, 12, 14, 16). The first division of the megaspore mother cell nucleus is quickly followed by the second, the result being a tetrad of potential megaspores (FIG. 18). The first division is usually followed by the formation of a cell wall as in FIG. 22 and 24, but this is not always the case, as is shown in FIG. 23. These divisions are usually transverse as shown in the cell at the left in FIG. 16, in the middle cell of FIG. 15*a*, and in FIG. 24. The resulting megaspores usually lie in a row parallel to the long axis of the nucellus (FIG. 18). That the first division may be longitudinal is shown by preparations similar to that in FIG. 10, and that the later divisions may vary from a transverse direction is shown in the upper cell in FIG. 22. From such divisions we might expect the formation of two parallel rows of two megaspores each, or a row of two parallel to the long axis of the nucellus with another transverse pair, as described for *Symplo-*

carpus foetidus by Rosendahl (6, p. 3). Where more than one megaspore mother cell is in a nucellus, division of all the nuclei proceeds regularly and may or may not be simultaneous. The most nearly simultaneous cases found are shown in FIG. 9, 19, 19*a*. Finally, limited space probably causes a crowding in such cases, which results in the checking of activity in some cells and their destruction by the growth of others, as suggested by the cells at the left in FIG. 15, 15*a*.

A few preparations show a cell in a position to indicate its origin as a tapetal cell (FIG. 17*t*). The same possibility is suggested by Gow (5, p. 39–40), in FIG. 6, and is also mentioned by Campbell (3, p. 7) for *Dieffenbachia Seguine*. Such a tapetal structure is shown to be well developed normally in *Symplocarpus foetidus* by Rosendahl (6, p. 2, *pl. 1. f. 4* and *pl. 3. f. 31*). The finding of but one such cell showing disorganization as the megaspores develop seems to the writer sufficient evidence to justify the conclusion that the formation of a functional tapetum in *Arisaema triphyllum* is unusual or even questionable.

As has been stated above, during the enlargement and divisions of the megaspore mother cells, the outer cells of the nucellus undergo periclinal divisions until the sporogenous cells appear quite deeply seated. During the same time the nucellar cells become well filled with starch (FIG. 15 and 17). As a result of the later gametophyte growth, the lateral portion of the nucellus with its contained food material is consumed, so that the mature embryo-sac is in contact with the inner integument, except at the apex, where a cap of nucellar cells persists (FIG. 20 and 21). The temporary storage of food where it is so readily available for use by the growing embryo-sac may account for the rapid development of the latter as given below.

THE EMBRYO-SAC

One of the megaspores develops into the embryo-sac at the expense of the others and of the nucellar tissue. Three nuclear divisions occur in rapid succession as in *Symplocarpus foetidus* (6, p. 3). The short time required for these divisions is indicated by the fact that out of many preparations of material gathered at one time, and showing about this stage, but very few show

anything between the first nuclear division of the megaspore (FIG. 20) and the mature embryo-sac (FIG. 20). The daughter nuclei of the first division remain centrally located in the cell until after the second division (FIG. 26). Later a normal egg cell and two synergidae are formed close in the apex of the embryo-sac, and in some cases three antipodals are present (FIG. 20). The antipodal cells are poorly developed however, only occasionally showing typical angiosperm structure, and never showing the remarkable development described by Campbell (3, p. 11) and Rosendahl (6, p. 5) for other members of the Araceae. As far as the writer has been able to determine, the polar nuclei show no such fusion as described by Gow (5, p. 41), but remain separate as in *Anthurium* (3, p. 15). In every case where a polar nucleus was observed after fertilization of the egg, the lower one was found separate, greatly enlarged, and often disintegrating near the antipodals. Further details concerning the fate of the polar nuclei and of the antipodal structure will be more fully dealt with in a subsequent paper.

Where more than one tetrad of potential megaspores are formed in one nucellus, the usual course of events is for some one cell from one tetrad to germinate while the other spores are crushed or broken down. In rare cases more than one embryo-sac have been found developing in the same nucellus. In one ovule two well-developed embryo-sacs were found side by side and of approximately the same size, but unfortunately one lay directly beneath the other in the section. The only preparation showing two such structures in the same section is shown in FIG. 21. These present a marked difference in size as well as deficiencies in antipodal structure. As stated above, such imperfect development of antipodals is not rare in otherwise normal embryo-sacs.

SUMMARY

The present study has verified most of the findings of other investigators, but has given results at variance with their reports in regard to the following points.

(*a*) The origin of the several megaspore mother cells from a single primary archesporial cell is doubtful.

The first division in the formation of the tetrad has been probably mistaken by earlier investigators for a division of a primary archesporial cell into embryo-sac initials.

(*b*) The formation of a tetrad of potential megaspores from some of which the embryo-sac or sacs develop, instead of from an archesporial cell, is shown.

(*c*) More than one embryo-sac may be developed in *Arisaema triphyllum*, as Campbell (4, p. 671) has shown for other members of the Araceae.

(*d*) The fusion of the polar nuclei is doubtful.

(*e*) The antipodal cells rarely develop fully as in typical angiosperms.

The writer wishes to express his gratitude to Prof. D. M. Mottier of Indiana University, at whose suggestion the present study was undertaken, for his kindly critical and encouraging words.

INDIANA UNIVERSITY, BLOOMINGTON, INDIANA.

LITERATURE CITED

1. **Strasburger.** Die Angiospermen und die Gymnospermen. 1879.
2. **Mottier.** On the development of the embryo-sac of *Arisaema triphyllum*. Bot. Gaz. **17**: 258–260. Au 1892.
3. **Campbell.** Studies on the Araceae. Ann. Bot. **14**: 1–25. Mr 1900.
4. **Campbell.** Studies on the Araceae. Ann. Bot. **17**: 665–687. S 1903.
5. **Gow.** The embryogeny of *Arisaema triphyllum*. Bot. Gaz. **45**: 38–44. Ja 1908.
6. **Rosendahl.** Embryo-sac development and embryology of *Symplocarpus foetidus*. Minn. Bot. Stud. **4**: 1–10. Je 1909.

Description of plates 13 and 14

All drawings were made with the aid of a camera lucida.

FIG. 1. Longitudinal section of a young ovule with two megaspore mother cells in normal position shortly after the beginning of differentiation. ×225.

FIG. 2. Longitudinal section of young ovule with three sporogenous cells differentiated. The two lower cells may be considered as lateral hypodermal cells. ×225.

FIG. 3. Longitudinal section of ovule slightly larger and older than those shown in FIG. 1 and 2, but without any clearly differentiated sporogenous cells. ×225.

FIG. 4. Longitudinal section of very young ovule before differentiation of sporogenous cells and beginning of integuments. ×335.

FIG. 5. Longitudinal section of ovule showing lateral megaspore mother cell, a possible tapetal cell at the right, and the beginning of periclinal division of epidermal cells. ×225.

FIG. 6. Longitudinal section of ovule showing one megaspore mother cell and completed periclinal division of epidermal cells. ×225.

FIG. 7. Cross section of nucellus showing layer of 2 to 3 cells surrounding three megaspore mother cells. ×335.

FIG. 8. Longitudinal section of the whole ovule and part of ovary walls. ×225.

FIG. 9. Cross section of nucellus similar to FIG. 7, but showing different arrangement of megaspore mother cells. This shows very nearly simultaneous preparation for nuclear division. ×335.

FIG. 10. Cross section of nucellus showing the spindle of a longitudinal first division of a megaspore mother cell. ×335.

FIG. 11. Longitudinal section of nucellus with four megaspore mother cells. The position of the two at the left suggests a possible origin from a common archesporial cell. ×225.

FIG. 12. Longitudinal section of ovule to show the development of the integuments at the time of preparation for first tetrad division. ×125.

FIG. 13. Cross section of nucellus to show irregularity of periclinal division of outer cells. ×335.

FIG. 14. Longitudinal section of ovule to show the development of integuments at the time of the first tetrad division. ×125. (See FIG. 16.)

FIG. 15. Longitudinal section of nucellus showing some sporogenous cells crushed by the growth of others. ×250.

FIG. 15*a*. Sporogenous cells of FIG. 15. ×830.

FIG. 16. Higher magnification of the nucellus shown in FIG. 14. ×250.

FIG. 17. Longitudinal section of nucellus showing a possible tapetal cell, *t*. ×250.

FIG. 18. Longitudinal section of nucellus showing a row of four potential megaspores. ×250.

FIG. 19. Longitudinal section of nucellus showing two megaspore mother cells, one below the other. ×250.

FIG. 19*a*. Sporogenous cells of FIG. 19. ×830. The nuclei are in synapsis.

FIG. 20. Longitudinal section of ovule with one mature embryo-sac. ×160.

FIG. 21. Longitudinal section of ovule with two embryo-sacs. ×160.

FIG. 22. Longitudinal section of nucellus showing the second tetrad division and the wall formed after the first division. This shows the sporogenous cells buried unusually deep. ×250.

FIG. 23. Same as FIG. 22, but without any cell wall after the first division. ×250.

FIG. 24. A later stage than in FIG. 22. ×250.

FIG. 25. Section of a megaspore showing the first nuclear division. ×830.

FIG. 26. Section showing four nuclear stage in the development of the embryo-sac. ×830.

Is salinity a factor in the distribution of Nereocystis Luetkeana?*

GEORGE B. RIGG

Under an appointment from the United States Bureau of Soils the writer has investigated the kelps of the Puget Sound region as a source of potash fertilizer. This work was done during the summers of 1911 and 1912. During 1912 attention was given in particular to a study of the effect of fresh water on the growth of the bladder kelp (*Nereocystis Luetkeana*) as seen in the bed in Freshwater Bay near the mouth of the Elwha River. The Elwha is a snow-fed stream originating on the southwestern slope of Mount Olympus. It flows north and discharges into the Strait of Juan de Fuca some six miles west of the city of Port Angeles, Washington. It is the largest stream flowing into the Strait of Juan de Fuca or Puget Sound from the Olympic Mountains. The monthly maximum and minimum discharge of this river is reported in the Report of the United States Geological Survey,† in cubic feet per second, for the period of October, 1897, to December, 1898. For the portion of the year 1897 covered by this report the maximum discharge occurred in November and was 7,075 second feet, while the minimum occurred in October and was 171 second feet. For 1898 the maximum (3,282 second feet) occurred in June and the minimum (330 second feet) occurred in October. The mean for the period reported is 1,444 second feet. These observations were taken at McDonald, Washington. This is above the outlet of Lake Sutherland and also the outlet of Little River, so that the actual discharge of the river was somewhat greater than the above figures show. Mr. G. W. Northrup, superintendent of the operation of the power plant of the Olympic Power Company on the Elwha, states that the minimum discharge of the river for the year 1912 has been between 400 and 500 second feet, and that the maximum reaches an enormous amount each year during flood water periods, that is, in May and November.

† Published by permission of the Secretary of Agriculture.

* Twentieth Annual Report of the United States Geological Survey, Part IV, p. 531.

FIG. 1. Map of Freshwater Bay, Washington. Drawn from U. S. Coast and Geodetic Survey Chart no. 6300; kelp bed (*Nereocystis*) shown by ////////; soundings given in fathoms; dotted area indicates shoal water.

Freshwater Bay does not form a harbor. The distance in a straight line from Angeles Point, which marks the eastern side of the bay, to Observatory Point at its western side is four miles, while the maximum distance to shore in the bay, measured at a right angle from the above line, is only one mile. The strong tidal currents flowing in and out through the Strait of Juan de Fuca sweep freely through this bay. There is a good beach along practically the whole bay. The field observations on the kelp beds in this bay were made on September 11 and 12. On September 11, the surf was so heavy that it was deemed impracticable either to enter the mouth of the river in the 50-foot launch in which the trip was made, or to land with a skiff in the more exposed portion of the bay. The launch was anchored in the more protected portion of the bay behind Observatory Point. A landing was readily made with the skiff from this point. On the afternoon of September 12, the water in the bay was much quieter and we entered the mouth of the river in the launch.

There is no kelp at all opposite the mouth of the Elwha River. The river enters the bay by two mouths and the first kelp plants found were about half a mile west of the west mouth. At this end of the bed the kelp plants are scattering and of medium size. A little farther west the bed becomes quite dense, and continues so to a point near Observatory Point. The bed is not closer to the b ach than one fourth of a mile at any point. The bed is more than 500 feet wide in places and is over two miles long. There is also a good deal of kelp around Observatory Point. The bladder kelp (*Nereocystis Luetkeana*) is the only kelp found growing in this bed. *Macrocystis pyrifera* was found floating in the bay, but not attached.

Hydrometer readings to determine the density of the water were made at the most eastern point at which kelp was found in the bay, at the west end of the bed, and at several intermediate points. Readings for comparison were made at several points in the open Strait also. A reading was made in the mouth of the river and one at a point about 500 feet directly out from the mouth. All readings were taken at a temperature of 15.5° C., that being the temperature to which the zero point of the instrument used was adjusted. The water of the river proved to be

exactly this temperature, while the samples from the kelp bed and the open Strait varied from 12.5° C. to 13.5° C. There was found to be no difference in the hydrometer readings taken in the open Strait and those taken at any of the points where kelp grew in the bay. The reading taken in the mouth of the river was zero. The reading taken about 500 feet straight out from the mouth of the river showed about one third as great a salinity as the water of the Strait and of the bay.

The facts are, then, that a strong tidal current sweeps freely through this kelp bed, and the water at all points in it shows the normal salinity of the water of the Strait. So far as this bed is concerned kelp does not grow in water that has less than the normal salinity. It does not seem quite possible, however, to say positively that the lack of normal salinity is the only inhibiting factor preventing the growth of kelp near the mouth of the river, although it seems to the writer that such is probably the case. Outside of the question of the salinity of the water, there are at least three factors that limit the distribution of *Nereocystis* in the Puget Sound region. These are rocks for anchorage, a strong tidal current, and proper depth of the water. The strong tidal current is present at the mouth of the river, as it is in the other portions of the bay, and the water is of proper depth for kelp, a little distance off shore, as it is in the other portions of the bay, where kelp does thrive abundantly. It may be possible that the silt brought down by the river has so covered the rocks near the mouth of the river as to render the attachment of kelp impossible.

Two sets of samples were collected—one set from the extreme western end of the bed (over three miles from the mouth of the river) and one set from the extreme eastern end (the portion of the bed nearest the mouth of the river). The analysis of these samples is shown in the following table.

The above figures should not be construed as indicating positively any characteristic difference in the potash content of the kelp from the two ends of the bed. It will be noted that sample number 3 has a much higher potash content than any other sample reported in the table. Neglecting this one, the samples from the west end of the bed average about one per cent higher in potash than the samples from the east end. This, however, should be

considered in the light of the fact that two samples of fronds collected by the writer in the Brown's Island bed near Friday Harbor, Washington, in 1911, and analyzed by Dr. J. W. Turrentine of the United States Bureau of Soils differed in their potash content by 9.7 per cent.*

COMPOSITION OF KELP SAMPLES (*Nereocystis Luetkeana*) FROM FRESHWATER BAY, PUGET SOUND. Collected by George B. Rigg. Analyses by E. G. Parker and J. R. Lindemuth, U. S. Bureau of Soils. Nitrogen determinations by J. C. Trescott, U. S. Bureau of Chemistry.

No.	Locality	Portion of plant	Potash, per cent.	Nitrogen, per cent.	Iodine, per cent.	Soluble salts, per cent.	Organic matter, per cent.	Ash, per cent.
1	From west	Fronds	18.04	2.26	0.23	44.17	51.13	4.80
2	end of bay	Fronds	17.61	2.21	0.24	44.70	51.11	4.72
3		Stipes	31.62	1.21	0.25	63.75	33.15	3.46
4	From east	Fronds	16.92	2.57	0.20	43.37	51.16	5.47
5	end of bay	Fronds	17.05	2.71	0.24	41.53	51.67	6.30
6		Fronds	17.32	2.53	0.28	45.40	50.12	4.48
7		Fronds	16.20	2.54	0.19	42.88	52.19	4.98
8		Stipes	16.50	2.21	0.30	59.24	37.40	3.36
9		Stipes	16.72	1.46	0.20	57.06	39.02	3.92

It is quite possible that in some states of tide and current the water may be less saline at the east end of the bed than at the west end, and that this may account for the slightly lower potash content in the samples from the east end.

There seems to have been little previous work done on the influence of the varying salinity of water on the growth of the Laminariaceae. Setchell† says that "Exact figures are wanting" and that "Recourse may be had only to general experience and statements can be couched only in general terms." He says that a few Laminariaceae "ascend tidal rivers to a slight extent." The writer has not found any instance of this in the Puget Sound region, but his investigation particularly of the smaller leaf-like species has not been by any means complete.

Setchell notes the fact that Fucaceae and Ulvaceae are found in tidal rivers. This is true in the Puget Sound region. It is interesting in this connection to note that a *Pelvetia* plant has even been found growing in a salt marsh in this region. The specimen

* Sixty second Congress, Second Session, Senate Document No. 190, p. 220.

† Ibid., p. 135.

referred to was found by Dr. T. C. Frye in a marsh near Toke Point, Washington.

While the writer has not made any detailed investigations in regard to the growth of Laminariaceae near the mouth of any other river than the Elwha, his general observations as well as his conversations and correspondence with other observers lead him to believe that kelps are to be looked for in this region only where the water has practically the normal salinity of sea water.

UNIVERSITY OF WASHINGTON, SEATTLE.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1910–1913)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

Ames, O. *Orchidaceae* novae et criticae insularum Philippinarum. Leaflets Philip. Bot. **5**: 1549–1588. 12 D 1912.
Forty-two new species are described.

Andrews, A. L. Notes on North American *Sphagnum*. IV. Bryologist **16**: 20–24. Mr 1913.

Andrews, A. L. Philological aspects of the "Plants of Wineland the Good." Rhodora **15**: 28–35. 4 Mr 1913.

Bachmann, F. M. The migration of *Bacillus amylovorus* in the host tissues. Phytopathology **3**: 3–14. *pl. 2, 3 + f. 1, 2.* F 1913.

Barss, H. P. Cherry gummosis. Biennial Crop, Pest and Horticultural Rep. Oregon Agr. Exp. Sta. **1911–1912**: 199–217. *f. 10–19.* 10 Ja 1913.
Caused by *Pseudomonas Cerasus*.

Bean, W. J. *Prunus pennsylvanica*. Curt. Bot. Mag. IV. **9**: *pl. 8486.* Mr 1913.

Blewitt, A. E. Notes on *Euphorbia Cyparissias* L. Rhodora **15**: 43. 4 Mr 1913.

Bödeker, [F.] *Mamillaria Wrightii* Engelm. Monats. Kakteenk. **23**: 20, 21. 15 F 1913. [Illust.]

Börgesen, F. Some *Chlorophyceae* from the Danish West Indies. II. Bot. Tidssk. **32**: 241–273. *f. 1–17.* 25 Je 1912.

Britton, N. L. Botanical exploration in Bermuda. Jour. N. Y. Bot. Gard. **13**: 189–194. *pl. 103–107.* D 1912.

Cannon, W. A. Some relations between root characters, ground water, and species distribution. Science II. **37**: 420–423. 14 Mr 1913.

Cockerell, T. D. A. Natural selection. Pop. Sci. Mo. **82**: 388–396. Ap 1913.

Cook, O. F., & Doyle, C. B. Three new genera of stilt palms (*Iriarteaceae*) from Colombia, with a synoptical review of the family. Contr. U. S. Nat. Herb. **16**: 225–238. *pl. 54–65* + *f. 41.* 21 F 1913.
Acrostigma, Catostigma, and *Catoblastus* gen. nov.

Dixon, H. N. A remarkable form of *Dicranella heteromalla* Schimp. Bryologist **16**: 29, 30. Mr 1913.
Reprinted in part from the Journal of Botany for October, 1912.

Evans, A. W. Revised list of New England *Hepaticae.* Rhodora **15**: 21–28. 4 Mr 1913.

Fernald, M. L. *Alnus crispa* (Ait.) Pursh, var. *mollis* (Fernald), n. comb. Rhodora **15**: 44. 4 Mr 1913.

Fernald, M. L., & Wiegand, K. M. The variations of *Luzula campestris* in North America. Rhodora **15**: 38–43. 4 Mr 1913.

Freeman, E. M. Harry Marshall Ward. Phytopathology **3**: 1, 2. *pl. 1.* F 1913.

Freeman, G. F. Southwestern beans and teparies. Arizona Agr. Exp. Sta. Bull. 68: 573–619. *pl. 1–10.* 30 Au 1912.

Gandara, G. Morfologia de las raices de las plantas. Mem. Soc. Cie. "Antonio Alzate" **30**: 7–10. *f. 1–12.* O 1910.

Gregory, C. T. A rot of grapes caused by *Cryptosporella viticola.* Phytopathology **3**: 20–23. *f. 1, 2.* F 1913.

Grout, A. J. Collecting mosses in Florida. Bryologist **16**: 27–29. Mr 1913.

Güssow, H. T. Report of the Dominion botanist. Rep. Exp. Farms (Canada) **1912**: 191–215. *pl. 6, 7* + *f. 1–4.* 1912.

Güssow, H. T. Powdery scab of potatoes. *Spongospora subterranea* (Wallr.) Johns. Phytopathology **3**: 18, 19. *pl. 4* + *f. 1.* F 1913.

Harper, R. M. Botanical evidence of the age of certain ox-bow lakes. Science II. **36**: 760, 761. 29 N 1912.

Hastings, E. G., Evans, A. C., & Hart, E. B. The bacteriology of cheddar cheese. Centralb. Bakt. Zweite Abt. **36**: 443–468. *f. 1, 2.* 15 F 1913.

Hedgcock, G. G. Notes on some western *Uredineae* which attack forest trees. II. Phytopathology **3**: 15–17. F 1913.

Hedrick, U. P. The domestication of American grapes. Pop. Sci. Mo. **82**: 338–352. Ap 1913. [Illust.]

Hill, E. J. The annulus of *Tortella caespitosa* (Schwaegr.) Limpr. Bryologist **16**: 17, 18. Mr 1913.

Holdt, F. von. Forstwissenschaftliches aus Nordamerica. Mitteil. Deuts. Dendr. Gesells. **1912**: 114–123. 1912. [Illust.]

Hubbard, F. T. Further notes on the Panicums of Essex County, Massachusetts. Rhodora **15**: 36–38. 4 Mr 1913.

Humphrey, C. J. Winter injury to the white elm. Phytopathology **3**: 62, 63. F 1913.

Jackson, H. S. Apple tree anthracnose. Biennial Crop, Pest and Horticultural Rep. Oregon Agr. Exp. Sta. **1911–1912**: 178–197. *f. 1–9.* 10 Ja 1913.

Caused by a fungus, ***Neofrabraea malicorticis*** (Cordley) Jackson, proposed as the type of a new genus.

Jewett, H. S. A moss "washing machine." Bryologist **16**: 25–27. *f. 1.* Mr 1913.

Johnson, A. G. Canada-thistle and its eradication. Purdue Univ. Agr. Exp. Sta. Circ. **32**: 1–12. *f. 1–3.* Ja 1912.

Kennedy, P. B. Studies in *Trifolium*—VII. Muhlenbergia **9**: 1–29. *pl. 1–5.* 7 Mr 1913.

Includes ***Trifolium insularum***, ***T. Helleri***, ***T. pseudo-albopurpureum***, ***T. Traskae***, and ***T. mercedense*** spp. nov.

Loomis, M. L. Some extensions of local ranges. Rhodora **15**: 44. 4 Mr 1913.

Lunell, J. *Erigeron* in North Dakota. Am. Mid. Nat. **2**: 253–258. 1 Jl 1912.

Lunell, J. A new *Gutierrezia* from Oregon. Am. Mid. Nat. **2**: 194, 195. 18 Mr 1912.

Gutierrezia ionensis sp. nov.

Lunell, J. A new *Laciniaria* from Florida. Am. Mid. Nat. **2**: 163, 164. 15 Ja 1912.

Laciniaria Deamiae sp. nov.

Lunell, J. New plants from Minnesota—II. Am. Mid. Nat. **2**: 159–162. 15 Ja 1912.

Lunell, J. New plants from North Dakota—VI. Am. Mid. Nat. **2**: 142–149. N 1911;—VII. Am. Mid. Nat. **2**: 153–159. 15 Ja 1912;—VIII. Am. Mid. Nat. **2**: 185–188. 18 Mr 1912;—X. Am. Mid. Nat. **3**: 12, 13. 6 Ja 1913.

Lunell, J. Some new *Laciniariae*. Am. Mid. Nat. **2**: 169–177. 18 Mr 1912.

Includes ***Laciniaria Deamii*** sp. nov.

Lunell, J. Synonymy alterations. Am. Mid. Nat. **2**: 264. Jl 1912.

MacClement, W. T. Some conditions of progress in the plant world. Ottawa Nat. **26**: 153–160. Mr 1913.

Macoun, J. M. Additions to the flora of Vancouver Island. Ottawa Nat. **26**: 160–168. Mr 1913.
Continued from p. 149.

Maxon, W. R. A new genus of davallioid ferns. Jour. Washington Acad. Sci. **3**: 143, 144. 4 Mr 1913.
Sphenomeris Maxon, gen. nov.

Melhus, I. E. *Septoria Pisi* in relation to pea blight. Phytopathology **3**: 51–58. *pl. 6.* F 1913.

Merrill, E. D. Notes on Philippine *Euphorbiaceae*. Philip. Jour. Sci. **7**: (Bot.) 379–410. D 1912.
Includes a new genus *Alcinaeanthus* and new species in *Antidesma* (1), *Bridelia* (1), *Cleistanthus* (1), *Cyclostemon* (3), *Excoecaria* (1), *Macaranga* (4), *Mallotus* (7), *Ostodes* (1), *Phyllanthus* (2), *Sapium* (1), *Sauropus* (1), and *Trigonostemon* (2).

Merrill, E. D. On the identity of *Evodia triphylla*. Philip. Jour. Sci. **7**: (Bot.) 373–378. D 1912.

Merrill, E. D. The Pineda monument and the probable site of the first botanic garden in the Philippines. Philip. Jour. Sci. **7**: (Bot.) 363–371. *pl. 22.* D 1912.

Meyer, R. *Echinocactus texensis* Hopff. Monats. Kakteenk. **23**: 28, 29. 15 F 1913.

Meyer, R. Über *Echinocactus Pfeifferi* Zucc. Monats. Kakteenk. **23**: 19, 20. 15 F 1913.

Morse, M. Inorganic colloids and protoplasm. Science II. **37**: 423–425. 14 Mr 1913.

Murrill, W. A. Collecting fungi in the Adirondacks. Jour. N. Y. Bot. Gard. **13**: 174–178. 23 N 1912.

Nieuwland, J. A. Box elders, real and so-called. Am. Mid. Nat. **2**: 129–142. N 1911.
Includes *Crula* gen. nov.

Nieuwland, J. A. New plants from various places. Am. Mid. Nat. **2**: 178–185. 18 Mr 1912.
Includes *Apocynum glaucum* and *Persicaria amurensis* spp. nov.

Nieuwland, J. A. Notes on our local plants. Am. Mid. Nat. **2**: 164, 165. 15 Ja 1912;—II. Am. Mid. Nat. **3**: 14–22. 6 Ja 1913;—III. Am. Mid. Nat. **3**: 41–47. Mr 1913.

Nieuwland, J. A. Our amphibious Persicarias. II. Am. Mid. Nat. **2**: 201–247. My 1912.
Includes *Persicaria tanaophylla* and *P. carictorum* spp. nov.

Nieuwland, J. A. A question of nomenclature. Am. Mid. Nat. **2**: 258–262. 1 Jl 1912.

Nieuwland, J. A. *Silene conica* in Michigan. Am. Mid. Nat. **2**: 264. 1 Jl 1912.

Nieuwland, J. A. Some local albino plants. Am. Mid. Nat. **2**: 265, 266. 1 Jl 1912.

Ochoterena, I. Memoria sobre las plantas deserticas mexicanas. Mem. Soc. Cie. "Antonio Alzate" **30**: 171–182. *pl. 4–6.* Mr 1911.

Pennell, F. W. Further notes on the flora of Conowingo or serpentine barrens of southeastern Pennsylvania. Proc. Acad. Nat. Sci. Philadelphia **64**: 520–539. 13 F 1913.

Porsild, M. P. Vascular plants of west Greenland between 71° and 73° N. Lat. Meddelelser om Grönland. **50**: 351–389. *f. 1–14.* 1912.

Prain, D., & Hutchinson, J. Notes on some species of *Acalypha*. Kew Bull. Misc. Inf. **1913**: 1–28. *f. 1–4.* Ja 1913.

Quehl, L. Über die Preisverzeichnisse der Kakteen. Monats. Kakteenk. **23**: 18, 19. 15 F 1913.

Reed, C. A. Wild flowers of New York. 1–46. Mohonk Lake, N. Y. 1912. [Illust.]

Robinson, C. B. Roxburgh's Hortus Bengalensis. Philip. Jour. Sci. **7**: (Bot.) 411–419. D 1912.

Rouaix, P. El arbusto llamado "hoja-sen" en los estados fronterizos (*Flourensia cernua* D.C.). Mem. Soc. Cie. "Antonio Alzate" **29**: 301–303. Je 1910.

Rydberg, P. A. Studies on the Rocky Mountain flora—XXVIII. Bull. Torrey Club **40**: 43–74. 18 Mr 1913.

Includes *Daucophyllum*, *Coriophyllus*, *Pseudopteryxia* and *Pseudoreoxis* gen. nov., and new species in *Lupinus* (1), *Psoralea* (2), *Atelophragma* (1), *Negundo* (1), *Sphaeralcea* (2), *Nuttallia* (2), *Epilobium* (5), *Gayophytum* (1), *Oenothera* (1), *Glycosma* (1), *Pseudopteryxia* (1), *Cynomarathrum* (1), and *Cogswellia* (1).

Schmid, G. Die Blüte des *Cereus Ocamponis* S.-D. Monats. Kakteenk. **23**: 29. 15 F 1913. [Illust.]

Serner, O. Kreuzungsresultate bei phyllokakteen. Monats. Kakteenk. **23**: 17. 15 F 1913.

Shear, C. L. *Endothia radicalis* (Schw.). Phytopathology **3**: 61. F 1913.

Smith, C. O. Some successful inoculations with the peach crown gall organism and certain observations upon retarded gall formation. Phytopathology **3**: 59, 60. F 1913.

Smith, G. M. *Tetradesmus*, a new four-celled coenobic alga. Bull. Torrey Club **40**: 75–87. *pl. 1.* 18 Mr 1913.

Tetradesmus wisconsinensis gen. et sp. nov.

South, F. W. Some root diseases of permanent crops in the West Indies. West Ind. Bull. **12**: 479–498. 18 S 1912.

Spaulding, P. Notes on *Cronartium Comptoniae*. Phytopathology **3**: 62. F 1913.

Speare, A. T. Fungi parasitic upon insects injurious to sugar cane. Rep. Exp. Sta. Hawaiian Sugar Planters' Assoc. Bull. **12**: 5–62. *pl. 1–6* + *f. 1, 2.* D 1912.

Includes *Entomophthora pseudococci* and *Aspergillus parasiticus* spp. nov.

Stapf, O. *Ruellia Harveyana.* Curt. Bot. Mag. IV. **9**: *pl. 8485.* Mr 1913.

A plant from Mexico.

Stout, A. B. A biological and statistical analysis of the vegetation of a typical wild hay meadow. Trans. Wisconsin Acad. Sci. **17**: 405–469. *pl. 18–23.* O 1912.

Vaupel, F. Vier von Ule in Nordbrasilien und Peru gesammelte Kakteen. Notizbl. Königl. Bot. Gard. Berlin **5**: 283–286. 25 Ja 1913.

Webster, H. S. Grape culture in Pennsylvania. Pennsylvania Dept. Agr. Bull. **217**: 7–66. *f. 1–51.* 1912.

Includes notes on the fungus diseases of grapes.

Weed, C. M. Portraits of American trees, native and naturalized, with a guide to their recognition at any season of the year and notes on their characteristics, distribution and culture. House and Garden **9**: 269–275. Je 1906.

Weingart, W. *Cereus Ocamponis* S.-D. Monats. Kakteenk. **23**: 30. 15 F 1913.

Wilcox, E. M. Smuts on Nebraska cereals. Nebraska Agr. Exp. Sta. Bull. **131**: 3–16. *f. 1–13.* 3 Au 1912.

Williams, R. S. The genus *Husnotiella* Cardot. Bryologist **16**: 25. Mr 1913.

Wolf, F. A. A new *Gnomonia* on hickory leaves. Ann. Myc. **10**: 488–491. *pl. 15.* 31 O 1912.

Gnomonia Caryae sp. nov.

Wollenweber, H. W. Pilzparasitäre Welkekrankheiten der Kulturpflanzen. Ber. Deuts. Bot. Gesells. **31**: 17–34. 27 F 1913.

Wollenweber, H. W. Studies on the *Fusarium* problem. Phytopathology **3**: 24–50. *pl. 5* + *f. 1.* F 1913.

Includes descriptions of *Fusarium redolens, F. conglutinans,* and *F. Sclerotium,* spp. nov.